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Bridge over the Theiss, and Tubular Foundations. By M. CEZANNE, Engineer des Ponts et Chaussées. Translated by J. BENNETT.

THE system of founding tubular piers by pneumatic fixtures is a happy imitation of a design conceived in 1841 by M. Triger for sinking a mine shaft in an island of the Loire, near Angers. It is but a few years since that it was adopted in England, and it has already met with many applications. Still, there are but few documents published upon the subject; and it is for this reason that I have undertaken to give an account of my own personal observations upon this matter.

The notice is divided into three parts:

The first contains a summary description of the bridge upon the Theiss, at Szegedin (Hungary), preceded by some indications of local circumstances. The second is devoted to iron arches. The third to tubular piers, and their pneumatic fixtures.

PART FIRST.

General Indications.—The South-east Austrian Railroad follows nearly the left bank of the Danube from Presbourg to Pesth. From this point, while the Danube bends to the south, the railroad is directed

to the south-east, and terminates at a quay upon the Danube, which it meets again at Basias.

This trace necessarily encounters all the affluents of the left bank, between Presbourg and Basias. The crossing of the Theiss is effected at Szegedin, 2·17 miles below its confluence with the Maros, upon a bridge, which is the object of this notice. By an agreement, dated June 10th, 1856, between the Austrian company and the imperial government, was determined,

1st, The trace of the centre line of the bridge.

2d, The distance between the abutments at 186 klofter, or 1157 feet.

3d, The height of the rails above the highest water of 1855, to be 26 feet.

It obliged the company to construct a durable bridge, and to finish all the work by July 1st, 1859, and remitted them one-half the duty upon wrought and cast iron.

These conditions allowed a great latitude to the company; and the study of the local circumstances controlled their decision.

The Theiss rises in the Karpathian Mountains, near the frontiers of Moldavia, of Bulkowine, and Transylvania. After coursing a circuit of 752 miles in a valley which is only 338 miles long, it enters the Danube, not far from Belgrade. Its gentle slope as compared with other rivers is seen in the following table, taken from a pamphlet by M. Michel, upon the navigation of the Danube.

Table of Slopes of some Rivers.

Name of River.	Slope per 1000 feet.		Difference between high and low water.	
	Feet.		Feet.	
Danube,	0·125	from Parsau to the sea.		
	0·400	above Vienna.	39·36	
	0·043	in Hungary.	29·52	
	0·0534	from Rassowa to the sea.	19·68	
Theiss,	0·028	from Tibisca-Uhlak, near its source, to the Danube.		
	0·0081	near the Danube.	14·76	
Rhone,	1·456	at its outlet from Lernau.		
	0·543	near Lyons.		
	0·742	at Valence.		
	0·288	at Tarascon.		
	0·053	at Aries.		
Rhine,	0·554		23·2	at inlet of canal from Rhone to Rhine.
Garonne,	0·440		30·7	at Ageu.
			42·6	at Langons.
Loire,	0·390		30·3	at Nevers.
Allier,			20·8	at Moulins.
Seine,	0·100		25·5	at Paris.
Nile,	0·144		42·7	at Upper Egypt.
Mississippi,	0·058		21·6	at Cairo.
Ohio,			65·5	at Cincinnati.

The velocity of the Theiss is generally from 0·98 feet to 1·96 feet at the surface; it attains, however, at Szegedin, 3·28 feet and 3·93 feet in high water.

The regime of the river is very regular. In spring the water rises slowly; it maintains nearly a constant level throughout the summer, and falls at the approach of winter. The minimum is always attained in the cold weather between October and March.

The highest water known, which was taken for a reference plane, occurred in April, 1855; the lowest water was observed in the winter of 1857–8, during the construction of the bridge; the difference was 26½ feet.

Hungary forms, between the Karpathes and the Danube, an immense triangular plain, which the Theiss traverses from the summit to the base, and which, in respect to public works, not many years since, was in a state of nature. The waters of the Theiss and of the Maros, at certain points, extended freely more than 43 miles from their beds, forming upwards of 247,114 acres of sorrily celebrated marsh.

One of the first essays for public improvement in Hungary was the formation, in 1846, of a vast syndicate of all the proprietors dwelling upon the Theiss and the Maros. A systematic regulation and endikement of the two rivers was undertaken. This work, interrupted for many years by the revolution, is now continued by the imperial government;* still, their effects are hardly appreciable, and it was admitted during the preparation of the project of the bridge, that there would be high water throughout the duration of the construction.

When the water stood at 20·4 feet, the width of the river on the site of the projected bridge was 738 feet.

The section of the profile was 1947 square yards. The delivery (calculated by the application of Eytelwein's formula to a great number of observations made with Woltmann's mill) was 1406 cub. yds.

And, consequently, the mean velocity was 0·72 yds. or 2·16 ft.

There is no stone or lime in the neighborhood of Szegedin; within 30 and possibly 60 miles range, cannot be found a pebble the size of a walnut. The sand itself must have been brought from afar, the river usually depositing a muddy slime, or occasionally a very fine sand, ill suited for masonry. Wood only is abundant, though the plain is barren as far as the limits of the horizon. The river brings it from Transylvania; it is usually composed of the trunks of pine, of a soft and coarse fibre, but of considerable length and diameter.

Szegedin was, in 1856, the head of the South-east Railroad, and so communicated easily with Pesth, where the Danube brought stone;

*The system adopted for this work consisted in substituting straight lines for the circuits of the river, and providing each bank with strong levees, 1312 feet apart. It was hoped by these means to increase the slope of the river, and to preserve the plain.

The diversion of the river was effected by digging a narrow canal during the low water, when they commenced enlarging and establishing its bed. Some of these diversions succeeded, they being navigable, while the ancient bed is under cultivation; but many of them have been filled up each year by the freshets, and can only be maintained by costly dredging; and the river has been entirely choked more than twenty times without subduing the perseverance of the dredgers. The sluggish and muddy waters of the Theiss and the Maros have a prodigious depositing power. We have seen at Szegedin, a single freshet deposit in a few weeks a bed of clay several yards in depth, and completely efface an enormous trench, excavated most zealously by the population of the city, who sought in it a remedy against the inundations which they anticipated from the construction of the bridge.

with Bohemia, where hydraulic lime was prepared; and finally, with France and England.

The low water being unusual, the Theiss is navigated at all seasons, except the icy, by steamboats from the Danube, and by large barges from 50 to 80 tons.

As for the bottom of the river, the soundings made in 1855 by the company showed, at the site of the projected bridge, an indefinite depth of very fine sand mixed with clay. It is easily undermined, but offers a certain resistance to compression.

General description of the Theiss Bridge.—The bridge at Szegedin (Pl. I., Fig. 1) is composed of eight rolled iron trussed arches of 136 feet span, supported by seven cast iron tubular piers, and two abutments in masonry, with one of which is connected a viaduct in masonry, with seven arches. The whole length of the structure is 1440·7 feet.

Arches.—The arches are parabolic in form; their sagitta is 16·84 feet.

Their springing is at 4·6 feet above the highest water on record.

The height for free navigation under the arches is, consequently, 21·4 feet.

Each arch is composed of four rolled iron trusses, each bearing a line of rails, and connected with each other by different systems of strutting. The two trusses belonging to each track are spaced at 5·7 feet.

The axes of the tracks are 13·12 ft. apart. The platform is formed of oak cross-beams, in section 9 ins. × 12 ins., and 28·5 feet long, spaced at 3·36 feet, and bolted upon the rolled iron trusses. These cross-sleepers bear directly the four lines of rails, the joist flooring, and the hand railing which bears the electric telegraph.

The length of cross-pieces is produced to 30·58 feet, projecting beyond the piers, thus allowing a space of 2 feet for the safety of the guards. There is no ballast upon the platform.

Piers.—Each pier (Pl. I., Fig. 2) is formed of two cast iron columns, 9·84 feet in diameter, bearing each a track, and consequently spaced 13·12 feet from axis to axis. These columns, whose sides are 1·37 ins. thick, are filled with piles and beton, and are connected by wrought iron stays. Their feet are enveloped with an enclosure of piles and sheet-piling, provided with beton, and protected by an enrockment.

The column properly so called, is surmounted by a cast iron capital, and by a square body of wrought iron, upon which are bolted the cast iron shoes which receive the ends of the trusses. The two square bodies of the same pier are strongly connected together by a system of diagonal braces.

The junction of the square bodies and the capitals is concealed by a wrought iron cornice.

The columns descend about 39 ft. below the summer level, or, say, 29·5 ft. into the bottom of the river. The point of the interior piles

penetrates 19·6 feet lower. Each pier is secured above by an ice breaker of oak.

The heads of the two neighboring piers are connected, and held at an invariable distance by the stringers of the trusses which they bear.

Abutments.—Upon the right bank, where lies the city of Szegedin, the earth is at the level of high water; the bank of the river is occupied below the bridge with merchandise platforms, and above by the city harbor. To maintain a communication between the harbor and these platforms, the abutment upon this bank has been prolonged by a viaduct. The first six arches are full centered, with a span of 18·53 feet. The last is surbased, and skewed 83°. It has in the axis of the bridge an opening of 31 feet. It is constructed in the helicoidal system.

The piers of the viaduct are of cut stone; the arches, spandrils, and return walls are faced with red and white brick.

The abutment proper is faced at the heads with cut stone, and with rustic-work at the four corners. In the interior of the mass, there are two modes of cut stone construction: one is in the form of an arch, and receives the springing of the iron arches; the other is composed of four walls stepped, starting from the rear summit of the abutment, and descending towards the springing of the arches (Pl. I., Fig. 1, dotted lines). These walls each receive a wrought iron moorring of the truss (2d part). The remainder of the abutment is built of rubble masonry. At the demand of the military engineers, two horizontal cast iron cylinders were imbedded perpendicularly to the axis of the bridge, serving the purpose of mining chambers.

Upon the left bank, there is no viaduct, and the abutment is connected with the embankment by return walls.

The two abutments are founded, in the same manner, upon a mass of beton, contained in an enclosure, and poured dry upon the piling designed to consolidate the bottom of the excavation.

There are 80 piles under the right abutment, and 120 for the total foundation of the left abutment; the heaviest loaded bear 88,000 lbs. Some were driven to an absolute refusal; the mean set was at $\frac{4}{10}$ths inch for 10 blows of a ram weighing 2200 lbs. with a fall of 19·6 ft. The beton is loaded at a maximum of 37·4 lbs. per square inch. The calcareous sandstone which receives the heels of the arches bore during the proof trial, 199·4 lbs. per square inch.

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PART SECOND.

Iron Arches.—The iron arches of the Theiss bridge are copies of the arch bridges constructed upon the Northern Railroad under the direction of M. Maniel, Engineer-in-Chief "des Ponts et Chaussées." They are composed (Pl. I., Fig. 1,) of rolled iron trusses, in which we may distinguish three parts:—

1st, The arch proper, which is parabolic, and with a rise of $\frac{1}{8}$ of the span.

2d, A horizontal top stringer, tangent to the summit of the arch.

3d, The spandrils formed of vertical equidistant uprights, and inclined struts, describing with the uprights a series of triangles decreasing towards the summit.

The section of these different pieces is a double **T**, formed of a web and of two stiffening plates fastened with angle-irons.

The pieces of the spandrils are connected with the arch and the top stringer in the same way; the webs of these pieces are prolonged until they meet with the web of the arch or that of the stringer, against which their section rests. The stiffening plates of the stringer or those of the arch return with their angle-irons, and envelop the stiffening plates of the spandrils, thus strengthening the section which without it would present a weak point where the angle-irons of the spandrils abut against those of the arch and stringer. The angles formed by the webs of the different pieces are filled exactly by wrought iron triangles, whose base is cut according with the curve of junction. Finally, the whole assemblage is enveloped with two covering plates, cut in the shape of a goose's foot, and presenting a scarf towards each piece.

The arch proper is traced so that the neutral axis of the different sections forms, from the first vertical upright to the last, a parabola, with a span of 134·78 feet, and a rise of 16·84 feet. The total opening of the arch from heel to heel is 135·85 feet.

The truss is divided into 20 equal sets by the uprights, which are 6·73 feet from axis to axis.

The five uprights of the summit are imaginary, being replaced by a wrought iron plate in full.

The stringer is not perfectly horizontal; it presents, besides the variations in thickness of the wrought irons, a camber of 1·37 inches, obtained at the moment of raising by an energetic wedging of the arches.

The two arches on the same side of the axis of the bridge bear one track; they are, from centre to centre, 5·7 feet.

The two middle arches are, therefore, 7·42 ft. from centre to centre.

The width of the intermediate space between the axis of the rails is 8·2 feet.

The four arches are made solid by three systems of connexion, viz:

1. A horizontal strutting in the plane of the neutral axes of the top stringers (Pl. I., Fig. 2).

2. A strutting whose surface envelops the neutral lines of the arches.

The drawings show the arrangement of these struttings, each member of which is formed of two **T** irons, riveted face to face, and at their ends embracing binding gussets, which are fastened to the trusses by two angle-irons.

3. A system of vertical stays or ribs distributed in three vertical planes on each side of the axis of a bay, to wit:

1. In the vertical plane of the second vertical strut two stages of diagonals.

2. In the vertical plane of the fifth vertical strut one stage of diagonals.

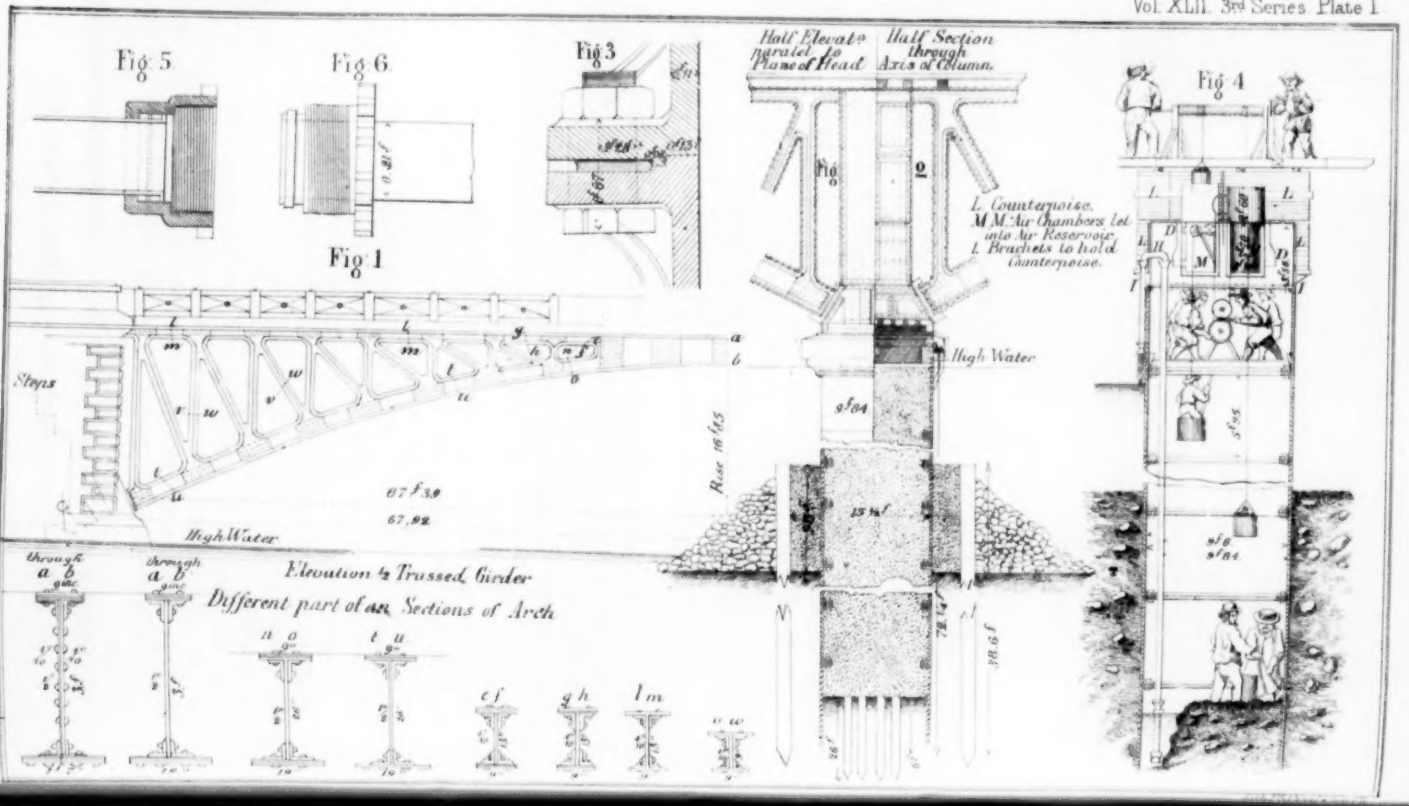


Fig 5
Fig 6
Fig 3
Fig 1
Fig 2
Fig 4
Half Elevation parallel to Plane of Head
Half Section through Axis of Column
L Counterpoise.
M M Air Chambers let into Air Reservoir.
L Brackets to hold Counterpoise.
Steps
High Water
Rise 16 f 5
Elevation ½ Trussed Girder
Different part of arch Sections of Arch
through a b
through c d
e f
g h
l m
n o
t u
v w

3. In the vertical plane of the eighth vertical strut one tier of diagonals.

These diagonals are formed of two **T** irons, opposed face to face, riveted at their ends upon binding gussets fixed upon the arches, and in their middle upon a plate of the same thickness as the gussets.

At the ends of the arches, a wrought iron plate perpendicular to the direction of the last element, is riveted upon two angle irons which are fastened to the web of the arch. This wrought iron plate bears upon the shoes through the intervention of iron wedges.

Against the abutments are interposed between the heel of the arch and its shoe, four couples of steel wedges, which are driven tight when a cold snap occasions any play between the heel and shoe (see Note A).

The top stringers enter into square bodies and abut against each other at the middle of the pier. They are not directly riveted together, but are connected by means of horizontal plates embracing them (Plate I., Fig. 2).

Upon the abutments the top stringers are received by a horizontal cushion of cast iron imbedded in the plinth. The web of the stringer is strengthened each side by two wrought iron plates ·43-inch thick; all these five plates are pierced with a hole, in which is inserted a steel dowel 1·98 inches in diameter, and projecting beyond each face of the stringer.

Two iron ties, 1·96 ins. diameter, wormed at one end and flattened at the other in form of a ring, lay hold of this dowel by their rings, and, penetrating the brick masonry which forms the platform of the abutment, traverse the upper stones of the stepped walls (Plate I., Fig. 1) and the cast iron pillows imbedded in these stones.

The wormed ends of these ties receive screws, whose tightening draws the truss towards the abutment.

The ends of the steel dowel are wormed and provided with nuts which hold fast the rings of the tie-rods.

All the parts of the trusses receive two coats of red lead paint, and two coats zinc grey.

A measurement of the bridge gives the following results:

Designation of parts.	Partial weights.	Number of parts.	Totals.
	lbs.		lbs.
An arch without its struttings,	59890·6	4	239,562
Strutting between two arches of the same track, . .	19617·4	2	39,235
Strutting of intermediate space,	20332·0	1	20,332
An entire truss, . . .			299,129

Weight per running foot $\frac{299129}{136}$ = 2,199 lbs.

If we compare with the total of the above table:

1st. The weight of the platform, of the tracks, and the hand rails, at	140,250 lbs.
2d. The weight of the proof load, about 2628 lbs. per running foot of track, ...	748,000 "
Total,	888,250 "

We see that the iron arch bears permanently ·47, and accidentally the triple of its own weight.

Theory of the Arches.—In the case of a uniform load, the equidistant uprights transmit equal weights to the arch; the curve of pressures or of equilibrium is a parabolic polygon, as in suspension bridges. If, then, the axis of the arch coincides with the parabolic polygon, there will not be, on the supposition of an incompressible arch, any tendency to derangement; the inclined struts will receive no thrust, and it will be easy to determine either by calculation or graphically the thrusts on each of the elements of the arch.

When the load is not uniformly distributed, the uprights transmit unequal pressures upon the arch, which, on the supposition of its being jointed, have a tendency to a change of form. If the uprights are connected by inclined struts forming a series of triangles incapable of a change of form, the arch will preserve its figure, but the inclined struts will produce reactions which must be taken into account in the study of the forces acting upon the different elements of the arch. This investigation may be made by a graphic process easily applied and which is suggested by the theory of the funicular polygon and that of jointed systems.*

This method being applied to the different hypotheses upon the position and magnitude of the loads will give, for the case considered, the value of the efforts in each of the elements of the arch. The section of each element will be determined by dividing the greatest of these efforts found for the element by the co-efficient of work adopted per foot of surface.

The co-efficient of work admitted for the Theiss bridge is, for the elements of the arch proper, which always resists compression, 5 kilogrammes per square millimetre, or 7122 lbs. per square inch.

For the uprights and inclines, which sometimes resist tension and sometimes compression, according with the position of the movable loads, 2 kilogrammes per square millimetre, or 2849 lbs. per square inch.

For the top stringer, whose parts act first as elements of the arch, then as beams fastened upon neighboring uprights and loaded on the middle with a part of the load, that of a locomotive axle for example, and finally as a tie between two piers (see the Third Part), the maximum co-efficient adopted was 7 kilogrammes per square millimetre, or 9971 lbs. per square inch.

The form of the elements and arrangement of the wrought iron pieces are not indicated by any theory, but by practical considera-

* The theory of this graphical process is thoroughly described in a memoir written for the Northern Railroad Company, advocating the projects of metallic bridges constructed upon the line from Saint-Quentin to Erquelines.

tions. It was also to facilitate the execution that a uniform section was adopted for all the inclines and vertical uprights, and that the section of the top stringer and that of the arch were not changed continuously. The top stringer presents only four different sections; the arch presents five, which increase from the springing towards the summit, contrary to the usual custom in metallic arches and in bridges of masonry.

The results of the resolution of the above mentioned efforts justify this anomaly. The weight of the structure being inconsiderable in comparison with that of the movable loads, the curve of pressures departs widely from the axis of the arch. Hence arises a tendency towards a change of form, which is resisted by the energetic action of the inclines; these actions modify the distribution of efforts in the arch and may increase those at the summit and diminish those at the springing line.

When the spandrils of the arch are not constructed so as to support without inconvenience the variations in efforts arising from the change of place of the movable load, it is requisite that the permanent weight should be such that the curve of pressures should not depart from the arch proper, or that it should remain within certain limits traced in this arch. This is a condition rigorously observed for arches in masonry or in cast iron.

Construction of Arches.—The wrought iron arches were forged in Wales, and worked at Paris by MM. Ernest, Gouin & Co. The riveting, as far as possible, was made by machinery.

The pieces of wrought iron were of such weights and dimensions that they could be stowed in the railroad wagons and so forwarded to Szegedin. Some wagons loaded at the work-shops of MM. Ernest, Gouin & Co., went through without change to Szegedin, having passed the Rhine upon the steam pontoon of *Ruhrort*. The greatest part, however, of the pieces sent from Paris were shifted at Dresden.

The trusses of wrought iron were again united at Szegedin, with the elements sent from Paris, and put in position without centerings in the following manner:

A service bridge of carpentry was constructed above the site of the bridge at the level of high water, which is below the springing of the arch. On this service bridge could be brought all the materials for the piers near to the work, and the passenger and baggage trains which were stopped at Szegedin by the Theiss, were forwarded by it towards Wallachia. It had in its middle a movable part, formed of an iron trellis bridge with 59 ft. opening in the clear, weighing 55,000 lbs. and was raised in one piece by four cranes on the passage of a boat. The service bridge was connected with the scaffolding of the piers, and with a stockade 8·2 ft. wide raised in the middle of each arch.

The arches were constructed upon the right bank in a great enclosure above the bridge, in which were assembled all the tools and plans of the work; they were laid horizontal and parallel to the axis of the bridge. To bring an arch in position it was made to undergo a series

of motions alternately perpendicular and parallel to the axis of the bridge during which it maintained its first direction; it was then brought upon the service bridge and drawn in front of the archway for which it was designed. By a final motion perpendicular to the preceding, the arch was pushed between the two piers upon which it was to rest. All these movements were made by means of iron wagons with four axles perpendicular to each other in couples and moved by strong screws (Plate I, Figs. 12, 13, and 14). The wheels of one system of axles were 4·92 ft. apart; those of the other were 9·84 ft. The same wagon being placed upon the crossing of a track of 9·84 ft., with a track of 4·92 ft. perpendicular to the first, could be pushed at will upon either track. It only required the regulation of the height of the movable axles so as to bring in contact with the rails those wheels answering to the track on which it was wished to move.

The method of moving the above named arches is readily seen. The arch is laid upon three wagons; one at the summit, the others at the ends. In the movements perpendicular to the bridge the three wagons advance parallel, each upon a track 4·92 ft.; these three tracks were cut at right angles by the track of 9·84 ft.; on arriving at the crossing, which occurs simultaneously for the three wagons, by manœuvring their movable axles, the whole system is pushed upon the 9·84 ft. track, parallel to the service bridge. Thus we arrive upon the service bridge by three tracks of 4·92 ft., and pass along it by one track of 9·84 ft., having the same axis as the regular tracks, and leave it by three tracks of 4·92 ft. placed upon the scaffolding of the piers at the level of the service bridge and upon the above mentioned stockade.

All the arcs are thus brought in their place. The mean distance of transportation for the majority of the arches was 1968 ft. upon six different directions and so with five crossings.

Motion was effected by two capstans, each worked by eight men; a portion of the track had a slope of 0·03; the velocity was about 9·84 ft. per minute. A change of direction required an hour. There were two crossings upon the service bridge, the one for entering and the other for leaving it. The whole distance between them had to be described in the interval of the passage of two trains.

It was at first proposed to bear the arches endwise upon two wagons only. Many trials for that purpose were made in the work-yard. The operation was found to be feasible but delicate, and any accident might have been attended with serious consequences; the men might be killed and the arch might fall into the river. It was decided to convey the arches flatwise, which multiplied the operations but lessened the chances of accidents.

The increased manœuvring exacted by the flatwise conveyance was considerable. It became necessary to construct a third track of 4·92 ft., that of the middle, and to manage three wagons instead of two. Moreover, the arches had no stiffness in the horizontal plane, and before laying them upon the wagons they had to be strengthened with

wooden trusses. Finally, the raising the arch in the vertical plane was much more complicated upon the river than in the work-yard.

This operation was accomplished by means of seven crabs, distributed along the arch, they laying hold of the horizontal top stringer; while the springings sustained by the wagons moved towards the crabs to keep pace with the raising. Nothing was easier than to effect this in the work yard where the crabs found a natural support upon the ground; but in the river it was necessary to construct a flying bridge from one pier to the other to hold up the crabs. It would then be necessary to construct similar flying bridges for all the arches, or to transport them from one arch to the other. The last method was adopted. The raising of the arch was thus composed of the following operations:

1. The establishment of a fly bridge, sustained by eight enormous beams about 65·6 ft. in length, and resting at one side upon the scaffolding and at the other upon the stockade in the middle.
2. The raising the trusses to stiffen, in a horizontal direction, the arch laid in the work-yard upon the wooden wedges.
3. The bringing the wagons under the arch (the tracks having been constructed before) and freeing the latter from the wedges which had supported it.
4. The landing the arch in its place.
5. The erecting of the seven hoisting crabs along the top cord.
6. The raising the arch, in the vertical plane, setting it in position, and wedging it upon the cast iron cushions.
7. The taking down of the crabs, and returning to the work-yard the wagons and wooden trusses to commence anew the same series of operations.

When one bay was raised, all the fixtures (crabs, stagings, "tendeurs," &c.,) had to be landed, and the flying bridge had to be taken down and moved to the next bay.

Notwithstanding the complication of these operations, the thirty-two arches of the bridge were raised with only one equipment of wagons, of crabs, and of fly bridges, in four months, without any interruption of the navigation or the stopping a single train. The eight last arches were raised in fourteen days, from the 9th to the 23d Oct., 1858.

Below are some principal dates of the construction:

November, 1856.—Approbation by the Minister of the plan proposed by M. Maniel, Director General of the Austrian Society. Conclusion with MM. Ernest, Gouin & Co. of the agreement for furnishing and *setting up* of the cast and wrought iron pieces. Shortly after, the conclusion of the contract for carpentry and masonry.

March 1st, 1857.—Driving of the first piles of the scaffolding and of the service bridge.

July 7th, 1857.—The laying of the first cast iron column.

November 23d, 1857.—Inauguration of the service bridge for the passenger and merchandise trains.

Dec., 1857, Jan. and Feb., 1858.—Winter; the thermometer varied from 14° to − 4° (Fah.) The works of the pneumatic foundations

and of masonry were suspended. The wrought iron was continued; piling was driven night and day in the cast iron columns.

March 23d and 24th, 1858.—A menacing ice-breaking for forty-eight hours, followed immediately by the opening of navigation and the renewal of the work.

June 15th, 1858.—Raising of the first arch.

Oct. 23d, 1858.—Raising of the thirty-second and last arch.

Nov. 23d, 1858.—The strutting and flooring of the bridge being finished, the trial proof was made.

Dec. 2d, 1858.—The inauguration.

Trial Proofs.—The bridge being uniformly loaded with (8000 kil. per metre) 5365 lbs. per running foot, and consequently the piers in equilibrium (see Third Part), the flexures were as a mean 0·47 ins. for the intermediate bays, and ·63 in. for the two end arches, whose top stringers were not moored upon the abutments (see Note A).

The passage of an ordinary train upon a track gives the following maxima deflections:

Upon the exterior arch of loaded track,	·31 inches.
Upon the interior arch,	·25 "
Upon the interior arch of unloaded track,	·14 "
Upon the exterior arch,	·08 "

Which proves that the four arches are, in a certain degree, solid.

(To be Continued.)

Description of a Pier erected at Southport, Lancashire. By Mr. H. Hooper, Assoc. Inst. C. E.

From the London Artizan, May, 1861.

This pier was constructed at right angles to the line of promenade facing the sea, on an extensive tract of sands reaching to low water, a distance of nearly one mile. Its length was 1200 yards, and the breadth of the footway was 15 feet. At the sea-end there was an oblong platform, 100 feet long, by 32 feet wide, at right angles to the line of footway. The superstructure was supported upon piers, each consisting of three cast iron columns, and each column was in three lengths. The lowest length, or pile proper, was sunk into the sand to the depth of 7 or 9 feet. These piles were provided at their bases with circular discs 18 inches diameter, to form a bearing surface. A gas tube was passed down the inside of each pile, and was forced 4 inches into the sand; when a connexion was made with the Water Company's mains, a pressure of water of about 50 lbs. to the inch was obtained, which was found sufficient to remove the sand from under the disc. There were cutters on the under side of the discs, so that, on an alternating motion being given to the pile, the sand was loosened. After the pressure of water had been removed about five minutes, the piles settled down to so firm a bearing that, when tested with a load of 12 tons each, no signs of settlement could be perceived. The upper lengths of the columns had cast iron bearing plates, for receiving the ends of the longitudinal lattice girders, each 50 feet long and 3 feet deep. The centre row of girders having double the duty of the outside

ones, top and bottom plates were added. The weight of wrought iron work in each bay was 4 tons 5 cwt., and of cast iron work 1 ton 17 cwt. The second bay from the shore was tested by a load of 35 tons, equally distributed, when the mean deflection of the three girders, in 24 hours, was $1\frac{1}{2}$ inches, and there was a permanent set of $\frac{1}{2}$ inch, on the load being removed.

The advantages claimed for this mode of construction were—1st, Economy in first cost, especially in sinking the piles, which did not amount to more than $4\frac{1}{2}d.$ per foot. 2d, The small surface exposed to the action of wind and waves. 3d, Similarity of parts, thus reducing the cost to a minimum. 4th, The expeditious manner of obtaining a solid foundation—an important matter in tidal work. 237 piles were thus sunk in six weeks.

The estimated cost of the pier and approaches was £10,400. The works had been completed for £9319, being at the rate of £7 15*s.* 4*d.* per lineal yard. The pier was designed by Mr. Brunlees, M. Inst. C. E., and the superintendence of the construction was entrusted to the author, as resident engineer, Messrs. Galloway being the contractors.

Proc. Inst. Civ. Eng., March 5, 1861.

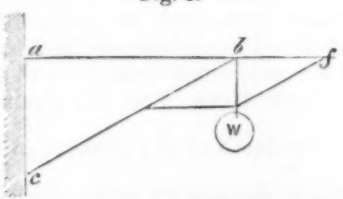
On Lattice Girders.

From the Lond. Artizan, May, 1861.

As girders constructed with a lattice web are now becoming numerous, it is very desirable that some ready means of calculating the strength or dimensions of any lattice combination should be generally known; we therefore purpose to enter fully into an investigation of the principles of such structures. Many theories of lattice girders have been published, all on the same principle, that we shall adopt in the present paper, and they are all tolerably simple, but with the one disadvantage of being expressed by trigonometrical qualities, and this we shall especially avoid, so that our calculations may be readily comprehended by those who have not studied the elements of trigonometry.

We will commence with some preliminary remarks upon the resolution of forces, confining ourselves to the problems which have reference to our present subject.

Fig. 1.



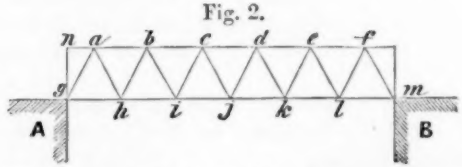
Let *b c* (Fig. 1) represent a beam fixed into a wall obliquely, as shown, and let its upper end be prevented from deflecting by a flexible tie *a b;* from the point *b* let a weight *w* be suspended, then will this weight be

transmitted to the wall $a\,c$ through the bar $b\,c$, solely for the tie $a\,b$ being flexible, cannot bear any part of the load when in a horizontal position, although it will be subject to a certain amount of tension, produced by the tendency of $b\,c$ to revolve round the point c. We may now state axiom No. 1; deduced from the foregoing remarks it is as follows:—

If a triangular frame of bars be fixed at two of its angles, and a force be caused to act at the remaining angle, its direction lying in the plane of the triangle, then will two bars be strained by forces acting in the direction of their length, viz., the bars containing the angle on which the force acts. No bending moment can act upon the bar $b\,c$, because its extremity $b\,c$ cannot deflect.

It now remains for us to find the intensity of the strain on the elements $a\,b$, $b\,c$, which we may accomplish by the well-known principle of the parallelogram of forces. Complete the parallelogram $b\,e\,\text{W}\,f$, then, if $b\,\text{W}$ represents the weight or force acting at the angle b, $b\,e$ will be equal to the strain on $b\,c$, and $b\,f$ or $e\,\text{W}$ will represent the strain on $a\,b$; hence, the three forces are represented by the three sides of the triangle $b\,e\,\text{W}$, which is similar to $b\,f\,\text{W}$, and also to $a\,b\,c$, hence the strain on $b\,c = \text{W}\,\frac{b\,c}{a\,c}$ and that on $a\,b = \text{W}\,\frac{a\,b}{a\,c}$, hence we may say, generally, if W is equal to the load carried by one inclined bar, as in the present case, d being the depth of the frame and L the length of the inclined bar, then the strain on the inclined bar will be, $\text{S} = \text{W}\,\frac{\text{L}}{d}$; and if l be the length of the horizontal bar, the strain on the horizontal bar will be, $\text{S} = \text{W}\,\frac{l}{d}$. This case is an exact illustration of the condition of the bars in a lattice girder, to which we will now turn our attention.

Fig. 2.



Let $a\,f\,m\,g$ (Fig. 2) represent a lattice girder composed of one series of inclined bars, whose extremities are maintained in position by the top and bottom horizontal members or flanches. Let us call W the load acting on any bar, supposing them to be all of equal length, then L being the length of the lattice bars, the strain on that one will be $\text{S} = \text{W}\,\frac{\text{L}}{\text{D}}$ where D is the depth of the girder. All measurements are from centre to centre of the pins by which the joints are united.

Let $v = a\,b = b\,c = h\,i = i\,j = etc.$ = the distance between two consecutive joints, then, if n equal the number of these distances, or of the triangles, the span of the girder is represented by $n\,v$. We will

first turn our attention entirely to the strains on the diagonal bars, leaving the flanches for a subsequent part of our paper. Let a load, W, be caused to act upon the apex *d*, *x* triangles distant from the pier A, then will that part of the load which is borne by A be the load upon the bars between *d* and A, and the remainder of W will be the load upon the bars between *d* and B. We may easily, by the laws of the lever, find the proportion of W borne by each point of support; but we will first pause to lay down our second axiom, which is, that *the strain on any lattice bar is due to and proportional to the load passing to a point of support situated so that the bar is between it and the load.*

The part of the load borne by B will be $= W \frac{x\,v}{n\,v} = W \frac{x}{n}$, and therefore the strain on any lattice bar between *d* and B will be $= W \frac{L\,x}{n\,D}$. We may similarly find the strain on the other part of the girder between *d* and A. The next point to be considered is the nature of the strain on any bar, and this is a matter of observation; thus it is compressive on *d k*, *e l*, etc., but tensile on *e k*, *f l*, hence our third axiom. *If the direction of any strain is from the foot of the diagonal towards the summit of the same, it is a tensile strain, and vice versa.* If there be an uniform load equal to *w* per lineal foot distributed over the whole girder, it will have the same effect as a number of small concentrated loads placed immediately above the apices or joints, each of which is equal to *w v*, and the total load on any bar may be found by ascertaining what proportion of each load passes through such bar to the piers, summing the tension and compression loads, and subtracting one from the other. We shall indicate all tensile strains by the sign — (minus), and all compressive strains by the sign + (plus). Let the load be placed upon the top flanch of the girder, then for the first joint, $x = \frac{v}{2}$; for the second, $x = \frac{3\,v}{2}$, etc.; and the proportion of any load borne by one pier is $= w\,v\,\frac{x}{n}$, *n* being constant, and being the denominator in every quantity; let, therefore, $w' = \frac{w\,v}{n}$, then the proportion of any load on one pier, the load being at a distance *x* from the *other* pier, is $= w'\,x$. The following summations show the strains on various consecutive diagonals, commencing at one of the piers, for the form shown in Fig. 2:

First bar	$\frac{w'\,L}{2\,D} \{1+3+5+7+9+11+\ldots+(2n-1)\}$
Second bar	$\frac{w'\,L}{2\,D} \{-1-3-5-7-9-\ldots-(2n-3)+1\}$
Third bar	$\frac{w'\,L}{2\,D} \{1+3+5+7+9+\ldots+(2n-3)-1\}$
Fourth bar	$\frac{w'\,L}{2\,D} \{-1-3-5-7-9-\ldots-(2n-5)+1+3\}$
Fifth bar	$\frac{w'\,L}{2\,D} \{1+3+5+7+9+\ldots+(2n-5)-1-3\}$

And so forth for all the others. By inspecting these series we notice that the strain on each tie is equal to that borne by the following strut, supposing the ties and struts to be of equal length. If the girder be suspended by the top flanches, as is sometimes the case, we shall commence with a tie instead of a strut.

Let us now take a practical case, whereby to exhibit the application of the above method. Let a bridge be required to carry a single line of railway, consisting of two girders composed of 10 equilateral triangles, such as are known as Warren's Girders, each division or base of a triangle, and therefore each lattice bar being 8 ft. long. The depth will then be 6·928 ft., which we will call 7 ft. Taking the weight of the bridge at $\frac{1}{2}$ ton per foot run, and that of the load at 1 ton, we have a total load of $1\frac{1}{2}$ tons, or $\frac{3}{4}$ ton on each girder, we will ascertain the strain on the various bars under a full load, allowing 4 tons per sectional inch for compression and 5 tons for tension in determining the sectional areas of the bars. $w' = \frac{w\,v}{n} = \frac{\cdot 75 \times 8}{10} = \cdot 6$, and $\frac{L}{D} = \frac{8}{7} = 1\cdot 143$ nearly; therefore, $\frac{w'\,L}{2\,D} = \cdot 3429$, say, $= \cdot 343$. Then the strains and sectional areas will be:

Bar.		Strain.	Sectional Area.
1st. ·343	$\{1 + 3 + 5 + 7 + \text{etc.} + 19\}$	= 34·3 tons.	8·575 sq. ins.
2d. ·343	$\{1 - 1 - 3 - 5 - \text{etc.} - 17\}$	= 27·44 "	5·488 "
3d. ·343	$\{1 + 3 + 5 + \text{etc.} + 17 - 1\}$	= 27·44 "	6·86 "

and so forth. It is evident that a total load would not produce the maximum strain on every bar, for there are both plus and minus signs in the series; hence to find the maximum strain we must make those terms which diminish the strain as small as possible, and those which increase it as large as possible. This is done by taking the former as produced by the weight of the structure only, the latter being calculated for the total load; w' will then have two values, one for the gross load $w' = \cdot 343$, and for the minimum load $w' = \cdot 114$. Then will the strains and sectional areas become:

Bar.		Strains.	Areas.
1st. ·343	$\{1 + 3 + 5 + 7 + \text{etc.} + 19\}$	= 34·30 tons.	8·575 sq. in.
2d. ·343	$\{-1 - 3 - 5 - \text{etc.} - 17\} + \cdot 114 \times 1$	= 27·67 "	5·534 "
3d. ·343	$\{1 + 3 + 5 + \text{etc.} + 17\} - \cdot 114 \times 1$	= 27·67 "	6·917 "
4th. ·343	$\{-1 - 3 - \text{etc.} - 15\} + \cdot 114\{1 + 3\}$	= 21·50 "	4·300 "
5th. ·343	$\{1 + 3 + \text{etc.} + 15\} + \cdot 114\{-1 - 3\}$	= 21·50 "	5·375 "

and so on. These are the minimum areas, and of their adoption we shall presently speak. We will now pass on to the top and bottom flanches,

first treating the strains upon them generally. We must again refer to Fig. 2. The strain on $g\,h$ will be that produced by the strains on $a\,g$, which is resolved vertically upon the pier and horizontally on the lower flanch; therefore, if the line $a\,g$ represents the strain on that bar, $a\,n$ equals the strain on $g\,h$; this strain passes on to h, where it is increased by the strain on $b\,h$, which is resolved between $h\,i$ and $a\,h$; hence the increment is represented by $a\,b$. When $b\,h$ is the strain on $b\,h$, this strain passes on again, being increased at every joint by a similar quantity until it meets, and is reacted upon by the strain acting in the opposite direction. The greatest strain on the flanches will exist when the bridge carries the total load. We will work out the strains on the flanches for the case we have selected first for the lower flanch. The strain on the first tension bar will be equal to the strain on the first diagonal $\times \frac{v}{2} \div$ length of diagonal; but the triangles being equilateral, $v =$ the length of diagonal; hence the strain on the first tension bar is half the strain on the first strut. The strain produced by that on any other strut is equal to the strain on such strut. The minimum strain and area of each tie-bar in the bottom flanch of one girder will be as follows:

Bar.	Strain.	Sectional Area.
1st. $\frac{34{\cdot}3}{2}$	$= 17{\cdot}15$ tons.	3·43 sq. in.
2d. $17{\cdot}15 + 27{\cdot}24$	$= 44{\cdot}59$ "	8·912 "
3d. $44{\cdot}59 + 20{\cdot}58$	$= 65{\cdot}17$ "	13·034 "
etc.	etc.	etc.

The strains on the lower flanch are all tensile and produced entirely by the strains on the diagonal compression bars or struts. The strains on the upper flanch are all compressive, and are due to the strains on the diagonal ties; they will be as follows:

Bar.	Strain.	Sectional Area.
1st.	$= 27{\cdot}44$ tons.	6·86 sq. in.
2d. $27{\cdot}44 + 20{\cdot}58$	$= 48{\cdot}02$ "	12·005 "
3d. $48{\cdot}02 + 13{\cdot}72$	$= 61{\cdot}74$ "	15·435 "
etc.	etc.	etc.

The strain on the first bar is obviously equal to v when the strain on the first tie is equal to the length of the tie. In Fig. 2, this bar is $a\,b$, for there is no strain on $n\,a$.

It now appears desirable to determine the most economical arrangement which may be given to the diagonal bars of a lattice girder.

We will suppose all the bars to be of equal length; then will the weight of the web be proportional to the sectional area of one bar multiplied into the length of the bar, and the number of bars. Let $v = 2\,z$; then, because the depth of the girder, z, and the diagonal, form a right angle triangle, $\text{L}^2 = z^2 + \text{D}^2$. The sectional area of one bar is proportional to the strain, and therefore to $\frac{\text{L}}{\text{D}}$, and the number of di-

agonals is proportional to the span of the girder $\div z$ D. If l = span of the girder, the weight of the web varies as

$$\frac{\text{L}}{\text{D}} \times \text{L} \times \frac{l}{z\,\text{D}};$$

but for any one case l and D remain constant. Hence the weight of the web varies as

$$\frac{\text{L}^2}{z};$$

and for the most economical disposition of the bars this will be a minimum. We will take a series of values for z, D being $= 2$:

When $z = 1$,	$\text{L}^2 = 5$,	$\frac{\text{L}^2}{z} = 5{\cdot}00$
$= 2$,	$= 8$,	$= 4{\cdot}00$
$= 3$,	$= 13$,	$= 4{\cdot}33$

Hence the value of z is between 1 and 3. We will take another series:

When $z = 1{\cdot}9$,	$\text{L}^2 = 7{\cdot}61$,	$\frac{\text{L}^2}{z} = 4{\cdot}0052$
$= 2{\cdot}0$,	$= 8{\cdot}00$,	$= 4{\cdot}0000$
$= 2{\cdot}1$,	$= 8{\cdot}41$,	$= 4{\cdot}0047$

From this series we conclude that the greatest economy is obtained when $z =$ D; hence our fourth axiom, *the lightest lattice web is obtained when the distance between two successive summits of the same system of triangles is equal to twice the depth of the girder.* The value of $\frac{\text{L}}{\text{D}}$ will, in this case, be

$$= \frac{\sqrt{z^2 + \text{D}^2}}{\text{D}}$$

$$= \frac{\sqrt{2\,\text{D}^2}}{\text{D}} = \sqrt{2} = 1{\cdot}4142.$$

The strain brought upon the flanches by any diagonal except the end ones will be equal to the strain on such diagonal $\times \frac{2}{\sqrt{2}}$, or it is equal to the load carried by such lattice bar $\times \sqrt{2} \times \frac{2}{\sqrt{2}}$ = twice the load carried by the lattice bar.

The strain brought upon the flanch by the last lattice bar = load upon diagonal $\times \sqrt{2} \times \frac{1}{\sqrt{2}}$ = the load upon the diagonal.

Let us work out the strains and the sectional areas for one girder constructed on the above plan, but consisting of two series of triangles, so that one series will sustain half the load on the girder.

Let the span of the girder be 30 ft., the distance between two joints in one series of triangles 6 ft., then the depth of the girder will be 3 ft. Let the load per foot run be ·75 ton. Then, proceeding as before,

$$w' = \frac{w\,v}{n} = \frac{{\cdot}75 \times 6}{5} = 9$$

for the two series, and ·45 for one series of triangles, for which latter

$$\frac{w' \text{ L}}{2 \text{ D}} = \cdot 318, \text{ nearly.}$$

The strain on, and areas of the diagonal bars of one series of triangles will be:

Bar.		Strain.	Area.
1st.	$\cdot 318 \{1+3+5+7+9\}$	$= 7{\cdot}95$ tons.	1·987
2d.	$\cdot 318 \{-1-3-5-7+1\}$	$= 4{\cdot}77$ "	0·954
3d.	$\cdot 318 \{1+3+5+7-1\}$	$= 4{\cdot}77$ "	1·192
4th.	$\cdot 318 \{-1-3-5+1+3\}$	$= 1{\cdot}59$ "	0·397

and so on. These are, as before, the theoretical areas for an uniformly distributed load. We will now take the strains for maximum loads, considering ·25 ton per foot run the weight of the structure, we shall have,—

Bar.		Strain.	Area.
1st.	$\cdot 318 \{1+3+5+7+9\}$	$= 7{\cdot}95$ tons.	1·987
2d.	$\cdot 318 \{-1-3-5-7\} + \cdot 106$	$= 4{\cdot}97$ "	0·994
3d.	$\cdot 318 \{1+3+5+7\} - \cdot 106$	$= 4{\cdot}97$ "	1·242
4th.	$\cdot 318 \{-1-3-5\} + \cdot 106 \{1+3\}$	$= 2{\cdot}44$ "	0·428

and so forth. The strains on the flanches may be worked out as before.

From these series we are induced to suspect that in some cases there are certain bars which act both as ties and struts; and this being a point of considerable importance, as will be shown hereafter, we will immediately ascertain under what circumstances this will occur. In calculating the maximum loads upon the diagonals, we are at liberty to consider whichever part of the girder we please as totally loaded, and in some cases we shall by these means find compressive and tensile strains acting occasionally on the same bar; thus, for instance, if we have a girder of 10 triangles, the weight of the structure being w, and that of the live load $2\,w$ per foot run, we have for the strain on the eighth bar,—

$$\frac{3\,w\,\text{L}}{2\,\text{D}} \{-1-3-5-7-9-11\} + \frac{w\,\text{L}}{2\,\text{D}} \{1+3+5+7\}$$
$$= -\frac{54\,w\,\text{L}}{\text{D}} + \frac{8\,w\,\text{L}}{\text{D}} = -\frac{46\,w\,\text{L}}{\text{D}}.$$

If the load be on the other side of the bar, the strain will become,—

$$\frac{w\,\text{L}}{2\,\text{D}} \{-1-3-5-7-9-11\} + \frac{3\,w\,\text{L}}{2\,\text{D}} \{1+3+5+7\}$$
$$= -\frac{18\,w\,\text{L}}{\text{D}} + \frac{24\,w\,\text{L}}{\text{D}} = \frac{6\,w\,\text{L}}{\text{D}}$$

hence we see that, at and near the centre of the span, the diagonals will act sometimes as ties and sometimes as struts. We must, there-

fore, make them sufficiently strong to bear either strain; such variations of strain cannot, however, occur at or near the points of support.

A few remarks are necessary before leaving this part of our subject, —on continuous lattice girders.

In this case we may take the central part of the girder, viz., that contained between the points of contrary flexure, and treat it as a lattice girder of the same span supported freely at both extremities. And the other parts may be treated as semi-beams loaded with an uniformly distributed weight and with a weight at the end, which latter will be equal half the load on the central part of the girder. We may thus give a general rule for this case; bisect the distance between the points of contrary flexure, then the load carried by any strut whose upper end is n triangles from the point of bisection and by the tie to which it transmits the load, will be, w being the load per foot run, and v the length of the base of one triangle, $n\,w\,v$, and the strain on such strut and tie is $\pm\ n\ w\ v\ \frac{L}{D}$.

We have hitherto, in every case except one, regarded the web as consisting of one series of triangles, but it more frequently occurs that a number of series are used forming a lattice web; then each series will bear an equal portion of the load. Thus, if the base of one large triangle equals v, in one series there will be a load on each apex equal to $w\,v$; but if there are m series of triangles, the load on each apex will be $\frac{w\,v}{m}$, or we may calculate the areas of the bars as if for one series, and subsequently divide these areas by the number of series of triangles employed. When only one or two series of triangles are used, totally distinct from each other, that is to say, not riveted or otherwise fastened together at the intersections of the diagonals, the girder is termed a triangular girder; but if a greater number of series are employed and riveted together at their intersections, it is called a lattice girder.

Having completed our investigation of the principles of lattice girders, we will make a few observations on the construction of them, particularly as regards the forms of the various elements of which they are composed.

The bars must never be made of less areas than those obtained by the foregoing calculations, and in many instances it will be necessary to make them of greater area.

In triangular girders, the ties may be of flat bars or plates; but all bars which act as struts must be provided with feathers along their whole length, and they may be conveniently formed of angle, T, or channel iron, with or without the addition of flat bars, according to the requirements of the case.

In lattice girders, consisting of many series of triangulations, it will not be necessary to make the struts with feathers, and the riveting together of the various lattice bars will make the web sufficiently stiff; but the girder should be provided with standards or stiffening plates

at frequent intervals, in the same manner as an ordinary plate girder, and in fact it requires a greater number of these to render it equally stiff with a plate girder. In triangular girders, the bars will increase in their sectional areas as we proceed from the centre of the girder towards either point of support; but in lattice girders it will be found more convenient to make the diagonals all of the same sectional area, the necessary strength being supplied by using a greater number of series of triangles as we approach the points of support. The number of series of triangles will not alter between two standards, as such an arrangement would be very inconvenient. The diagonals near the centre of a triangular girder must all be made as struts.

Over the points of support, it will be necessary to use very strong standards, or, what will be more convenient, moderately strong standards and a plate web.

Very open triangular girders cannot be made continuous with advantage, for in that case the web of the girder must be very materially altered at and near the points of support. The bottom flanch of a triangular girder may be made as bars or links, if the girder be not continuous; but the top flanch must be rigid, if the girder has a lattice web; or if continuous, both flanches must be rigid.

In triangular girders, the diagonals must be fastened to the flanches by strong pins, or by riveted joints. The latter method seems preferable, as imparting the greatest rigidity. The cross girders should be attached to strong standards, so arranged that the load may come first upon the joints in the top flanch; if otherwise, the calculations must be slightly modified to suit the case, for, when this occurs, the load on the struts will be somewhat different.

For the Journal of the Franklin Institute.

The Garonne, and the works executed upon it under the direction of M. Baumgarten. By Joseph Bennett, Esq.

The following account is made from notes taken some time since, on reading a report of M. Baumgarten, who for eleven years directed the works upon a portion of the Garonne, below the mouth of the Lot, and executed between 1836 and 1847. The steps taken to secure full information as to character of the river, the careful observations of Nature's workings in some mooted questions, and the zealous fidelity in mastering every thing that could throw light upon the subject, is quite interesting, and may, in a measure, serve as a guide for those having similar interests in charge. The report was accompanied with beautiful maps, showing the condition of the river before and after the works, with several elaborate tables, which served as a basis of comparison of the changes in the heights of water due to the works and of the different slopes affected by the river in different stages of water.

Between Agen and the Gironde Department, the Garonne runs through a fertile low plain, submersible for a quite regular breadth

of 2½ miles, its height varying from 16½ to 23 ft. above low water. It has but two bends and three alignments in the 42½ miles; the transverse slope of the low plain is nearly insensible, seldom reaching a difference of 3 ft., and in some cases lower at the foot of the hills than at the shore banks. The mean height above low water is 21 ft., and its slope the same as that of the river.

The free discharge of freshets in this plain is much impeded by *levees*, most generally detached and constructed at the caprice of the proprietors, without the supervision of the government. The levees are more or less submersible, and but a few are raised above highest freshets, thus protecting but isolated properties.

On the left bank, the plain is bordered by hills 147 to 197 ft. above the sea, and at their feet is the lateral canal to Garonne. The two principal affluents, the Ourbise and the Avance, whose valleys are respectively 1½ and 1 mile in width, on entering the plain, rise in the Landes, have a gentle slope, and bear only sand; the other 14 affluents rise in neighboring hills, presenting torrents, and bring down gravel.

These affluents, in coursing the plain, are generally enclosed between two levees, made by proprietors, so that their bed is even with and often above the adjoining plane; in most cases the plain to the right and left of these affluents, is raised from deposits of the streams.

Upon the right bank, between the mouth of the Lot and Tonneins, the range of floods is limited by the hills of Nicole, whose crests are 460 ft. above the sea. Below Tonneins, even to the Medier near Mongauzy, in Department of Gironde, a distance of 19 miles, these hills are separated from the low plain by a high plain having a mean width of 2·1 miles at Marmande, but contracting towards Mongauzy.

The transverse slope of the plain is hardly appreciable, and its longitudinal is the same with that of the low plane and river.

The three principal affluents of the right bank, the Tolzac, Trec, and Gupie, have moderate slopes, bringing down but slime; they make a sensible depression in the portions of the high plain they traverse.

The valley of the Garonne is hollowed out of the tertiary formation, which in this basin is composed of three fresh water deposits, between which are found two marine deposits. The lower fresh water deposit prevails in the Department Lot-et-Garonne, and is formed of alternate layers of clay, of tuffa (composed of small grains of white quartz, and felspar, and mica spangles), and of calc. The clays are very compact, of a white, red, yellow, and green color, having no fossils.

The bed of the river in the portion discussed, is composed of tuffa and clays; in some points the tuffa is exposed in extreme low water; its resistance, and that of the compact clays, limit the undermining, which in some cases, as at the Catalan rock and at Meilhan, are 49 ft. below low water; generally this earth is from 13 to 19 ft. below it, and is covered with a friable layer of gravel.

This first fresh water deposit is covered by the first marine deposit, similar to the calcareous formation in the environs of Paris. It appears only in the hills of the left bank between Avance and Meilhan,

but has a great development in the Gironde Department; from it came the enrockments made in the Garonne below Avance and Couthures.

Above the first fresh water deposit in the hills of the left bank is a layer of gravel, ferruginous, clayey, sometimes 13 ft. thick, which seems to be cotemporary with the great flood which hollowed out the Garonne valley. It is composed of stones from 12 to 15 inches long; it is silicious, with clayey schist and some granite, and is covered with a great thickness of deluvium. This gravel is not found in the hills upon the right bank, though they are 130 ft. higher than those on the left, and it is only found upon the high plain spoken of, and seems to have been deposited there in the formation of the valley by the washings from the left bank. The gravel of the low plain is finer than that on the left bank. In the lower part of these gravel deposits are found tusks and molars of elephants.

The low plain is the work of the actual régime of the Garonne, produced by the alluvion of the river, which, if free, would occupy the whole breadth of 2½ miles. This modern alluvium is from 33 to 39 ft. deep, alternating with sand, gravel, and silt, according to the velocity of the current which deposited it.

The nature of the gravel banks now transported by the Garonne is the same as that of the banks forming the summit of the hills of the left bank and the high plain of the right.

Windings and Variations in Bed of River.—Though the bed of high water has but one bend at Tonneins, the low water has twenty-one in the same extent so sharp that their radii at Tonneins, Meilhan, and Jusix, are respectively 338, 261, and 327 yards, making tangential angles 50°, 80°, and 40°. Thrice it touches the hills at Nicole, Tonneins, and Marmande on the right, and three times on the left bank, at Mas, Caumont, and Meilhan; thus a developed course of the mean bed shows a length of 33½ miles, while the corresponding part of the low plain has but 23 miles, or 68 per cent. of the former. This lessens the slope and velocity of water and increases the depth and ease of navigation.

The Garonne, acting freely, incessantly displaces its banks and encumbers its bed with the gravel deposits of its corrosions; giving birth to islands, which the works have partly caused to disappear; they all commenced as simple gravel banks, which, as they increased, were covered with a spontaneous growth, and so extended by the hand of man, they become powerful agents in the corrosions of the opposite banks.

From a comparison of ancient plans as far back as 1785 with those of 1827 and the actual condition of things in 1848, it appears in some places that the banks have stood intact for over 60 years without defences; in other places, as at the gravel bank of Sérénat, above Tonneins, the right bank has receded over 545 yds. from 1785 to 1827, or in 42 years has nearly completely shifted three times its ordinary bed. Other instances are recorded, showing great irregularities of progress; the greatest, those of Col-de-Fer and Fourques, not exceeding 16 to 17

yards per year; while at the Isle of Balias, Latuque, and Sainte-Bazeille, the corrosions were as a mean from 4 to 5 yards per annum.

From a careful study of charts showing the successive states of the banks, we do not always find, as indicated by theory, an alluvion in the rear of the convex part, which follows the concave corroded portion; for when the corroded bank is formed of silt, clay, and sand, the water holds them in suspension, and in a great freshet may bear them to the sea. The theory is only confirmed when the corroded banks are composed of gravel too heavy to be far removed. Some corrosions occur only in time of mean low water; they are caused by oblique gravel banks, which turn the currents against the opposite banks to undermine their base; other corrosions are due to the violence of direct currents in high water; but the greatest number arise from the sinking and sliding of the banks two or three days after the waters of a great freshet have returned to their bed, the earth being well soaked, after a long submersion, and urged forward by the water which finds a subterranean passage to the river, ends with a sinking of the banks. In this way towing-paths, which seemed in good condition the day after a freshet, have entirely disappeared three days afterwards.

The width of the bed is very irregular at low water; it may be between 76 yards, as at the Balias Isle, and 327 yards, as at the Isle of Meyniel; in mean water the width varies between 185 and 380 yds.

Movements of Gravel, Sand, and Silt.—The movements of materials may occur in three ways: 1st, when, by the limited velocity of current or the size of the material, it can only be borne discontinuously in rolling upon the bed. 2d, when the velocity is great and materials small, so as to be easily borne a considerable distance, though always in a discontinuous manner and without leaving the lower portion of the current. 3d, when the material is so minute as to be held in suspension, and may run continuously with the water for any distance. These three types represent the usual effects occurring in nature, though there may exist intermediate movements.

The materials of the first type are borne but a short distance; they are urged along a plane which rises in going down stream; at the end of this incline they find a greater depth, into which they fall, maintaining a steep slope; there they remain till covered by fresh accessions.

The division between this inclined surface and steep slope is marked by a salient edge, more or less inclined to the current, and which progresses from above downwards; this disposition is well seen in low water upon the great banks which were in motion during a freshet. The progress of one gravel bank above the Col-de-Fer was measured. In 1839, the edge commenced forming; in 1840, had acquired, on the lower slope, a height of 1·4 yards to a base 3 yards, and a length of crest 196 yards; in 1841, its form was nearly the same, having 1·37 yards height to 3·9 yards base, and had advanced parallel to itself 33 yards; in 1842, it had passed 22 yards lower, and in 1843, the sands below this slope were brought to a level. The original surface,

over which the gravel rolled, was not a plane, but convex with a constant form, the 29 yds. preceding the crest having a slope of ·046 ft. per foot, and upon the 29 yards below of ·062 ft.; the gravel was generally the size of a hen's egg, and the requisite velocity of the water to move them might be from 2 to 2·7 yards. The same thing occurs upon the banks which are not bare in low water, for in sounding the channel, wherever there has been a gravel movement, the depths decrease, going down stream till they arrive at a crest, where succeeds a depth 3 to 4 yards greater, in which whirls are formed with a horizontal axis parallel to the crest, and are designated as "foudres" by the navigators.

The gravel banks are often prolonged under the water to connect with those that lay bare, forming the two banks of the river; the crest then crosses the river obliquely and forms a bar. In high water the gravel raises this crest, thus forming a dam for low water; but this dam causes rapids and an excess of velocity, which dig out trenches across the crest and bear the gravel beyond the slope; so that, in a sudden fall of high water, the boats find a less depth in the passes, even with a large delivery, and some time after in low water these passes have not over ½-yard of depth.

The sand itself acts in this way when deposited in the secondary arms, which have a small velocity and tend to fill up.

The general movement of the gravel banks is much below 26 yards per annum, and this amount is attained only in marked changes of the bed, from corrosions of banks by works constructed in the usual bed, or in the submersible plain, tending to increase the velocity and destroy its former equilibrium.

It is certain that some gravel banks in the middle of the bed, and from 2½ to 3 ft. above low water, though subjected to the strongest currents, are not borne away by them. To prove this, in Nov., 1845, pieces of wood from 12 to 15 ins. long and 7 ins. diameter were sunk from 6 to 12 ins. in four places where the current was very strong; the surface of gravel and tops of sticks were compared with the level of nails upon the neighboring piles of the works. In Aug. 16th, 1846, three were found in the same place and the gravel was at the same height; the fourth, that found above Coussan, had been carried away, but the oak branches which had been placed along side of them, for the purpose of retracing the locality, though broken at the surface and laid horizontal by violence of water, were still attached to the stem fixed in the ground, and showed no marks of attrition, which must have been the case had the bed been obstructed by gravel driven by the water. The gravel banks of the Garonne, composed of pebbles two to three inches long, may thus be said to have but little movement at the present time. They have been formed from gravel deposits of a remote period, and, laying at a great height above the highest freshets, and are not brought down from the mountains at the present time, for then the bed of the river would be raised, but upon a great number of points, the water runs, not upon gravel, but upon the tuffa, clay, and rocks of the tertiary earth of the valley.

2d. The small gravel and sand of all dimensions form another portion of the bed and apply to the second adopted type of movement; they are generally mixed 20, 30, and 40 per cent. with the gravel, but in times of strong currents are separated and borne at great distances, surmounting the dams, lines of work, and banks, to be deposited in the first slack water; but generally these materials are too heavy to be borne continuously, and a freshet often deposits it at the height of 3 or 4 yards, either in secondary arms or in slack water behind the lines of work, and in eddies, but never in the channel proper.

These two modes of movement are heard on plunging a stick into the water.

3d. The slime brought down by torrents and affluents of all kinds after rain, generally finds its way to the sea, and only is deposited along the way in places where the velocity is insensible. It is this which fertilizes the alluvion; it may be in heights from 15 to 20 ins. per annum. That coming from the Tarn has a red chocolate color, from the Aveyron it is black, white from the Pyrenees.

Slope.—The leveling of the slope of an extended stream is quite a delicate matter, by reason of the variations in the heights of water, and because the partial and local heights of low water are by no means parallel to those of the mean and high waters.

The piles of the submersible dykes of the works, also piles driven on top of the bank behind the tow-path at every 500 metres and opposite the stone post marks, were used as benches. The pile benches were generally at 109 yards apart; careful levels gave their height above the mean level of the sea. On a given day and at a determinate height of water, the height of these bench nails was determined in the shortest possible interval of time. An iron rule 6½ ft. long, turning upon a hinge of an iron pillar secured to the head of the pile by a quarter collar and thumb-screw, was used for taking the measures. The rule was leveled by a spirit-level, and a cord with a copper bob at the end was let slip through a groove at end of ruler till it touched the surface of the water, and the distance was measured directly upon the ruler.

The length of the ruler enables one to measure outside of the small eddies in neigborhood of pier.

In 61,109 yards there were placed 584 benches, and 4 operators, each furnished with a rule, could take all the heights in a day, each having charge of 146 benches in a distance of 8·68 miles.

Thus with little cost exact levels were taken every year for different heights of water, whenever the bench nails (usually from 7 to 10 ft. above low water) were uncovered; for greater heights of freshets, the 10 road laborers for maintaining the tow-path marked upon the 500 metre stone marks the highest water, either by stakes or cuts on poplars planted for this purpose near them; the levels were then connected with the bench marks by the two navigating overseers.

As far as possible, the delivery was gauged each day of the leveling.

With these data of slope, height of water, and delivery carefully gathered in a long series of years, during which either the mean bed

or the bed of low water had been changed by the works of navigation, or the larger bed by dykes upon the plain, it was easy to solve the problems relative to the changes by these works upon the régime of the river.

Profiles were made of all these levels, and, the better to compare the slopes, a new profile of the levelings was made for each year, deducting from each the corresponding height of water of the scale of Tonneins diminished by one metre; or, in other words, all these lines of slopes were carried parallel to themselves, and made to pass through the same point at 1 metre above zero of the scale at Tonneins.* A mean straight line between all these curves gave the mean slope of water for the 34·6 miles in question. This line took a slope of 0·26525 ft. per 1000 ft.

This fictitious mean slope, around which oscillate the real slopes at different heights, admits of a better appreciation of their inequalities and variations.

We pass over the comparison of the low water (0·62 m. Tonneins scale) slope, with the details of its maximum and mean departures from the mean slope, showing at that stage 12 reaches with a mean slope of 0·119 feet and 12 rapids with a mean slope of 1·020 feet per 1000 ft., to say, that with the rise of water, these inequalities tend to disappear; for with the water at 2·6 m. (same scale) there were but five rapids. A comparison of the two curves of 0·62 m. and 2·60 m. shows that scales placed at the stations 86·3 k. and 104·5 k., so as to coincide when the water stood at 0·62 m. (Tonneins scale), disagreed 1·36 m. when the water stood at 2·60 of the same scale.

With the water at 5·57 m. at Tonneins, the slope became generally quite regular, properly speaking, without rapids, and the variations were due rather to the contours of shore banks, in horizontal projections, than to inequalities in the bed of the river. A comparison of it with 0·62 m. depth would show for two scales at stations 55 and 95, coinciding at the latter depth, a discrepancy of 1·97 m.

The freshet of February, 1846, which stood at 7·02 m. at Tonneins, had a nearly parallel slope with the curve of 5·57.

Transverse Profile.—Some engineers have thought that the water cambers in the middle, when it is rapidly rising, and that it becomes concave on the falling of the water. Eleven careful levelings were made near the mouth of the Avance, in a straight portion of the Garonne, unaffected by any centrifugal force, and between the hours of 10·45 A. M. and 5·15 P. M., at a time when the water was falling rapidly, and when it stood 5·80 m. on Marmande scale; during the fall of 2 feet in 6½ hours, the experiments showed no sensible difference; for as a mean, there was only a depression at the left bank of 0·065 feet below the right, the middle being 0·042 feet above the left, and ·023 feet below the right.

Some time after, the water standing at 3·90 m. on the same scale, observations were made in the same place, when the water was rising;

* To compare the changes made in the slopes by reason of the works, it was necessary to compare the slopes of the different years, reduced by calculation to one same height for a scale, where the water plane had not varied, and this arbitrary point was chosen as suited to that purpose.

the mean of nine observations made between 10 A. M. and 5½ P. M., gave the middle as 0·367 ft. above the right bank, and ·082 above the left. It was thought, however, that these observations, to be conclusive, should be often renewed, and in different localities; unfortunately, all was not ready at the fit time, and at another trial the fixtures were broken by a descending boat.

At Tonneins, in a great freshet, the centrifugal force raised the water 1·3 ft. against the left bank, at the summit of the concave bend.

Depth of Water in middle of River.—Soundings were made in 1836, when the works had but little affected the natural bed of the river. We omit the details, which show great inequalities of shallows and deeps. Most generally a shallow is found when the current changes its bank, excepting when the upper concavity is protected from corrosion. In low water, the greatest velocities correspond to shallows, and the reverse in high water. The cause of the irregularities of low water bed is to be found in the section and direction of the larger bed, and in the action of freshets upon them. When the high waters are accidentally directed towards a single point, either by dykes, or natural courses, such as in bends against insubmersible hills, great velocities are formed at the bottom, which dig out the bed, and deposit the gravel at the outlets of these passes.

Heights of Water.—We have seen that the different scales, though all referred to low water, differ among themselves; it was then important to choose one not subject to these anomalies, nor to changes in level produced by the works. Gaugings were made at different periods, at same heights of water, which prove that the plane has not varied at Tonneins; so that this scale was adopted. A table was made, which gave as a mean of 15 years, from 1832 to 1847, the number of days at which the water was held at different heights. Calling low water all below 3·28 ft., mean water between that and 7·28 ft., high water between that and 17·7 ft., and freshets all above that, there are for the 15 years—

69	days of	low water.
145	"	mean "
142	"	high "
9	"	freshets.

Or 287 days of good navigation; or, as navigation is not actually impeded except when the water is below 2 feet, which may happen for 22 days, there may be said to be 334 days of good navigation.

Calling the mean height of water that obtained in adding all the heights observed at noon, divided by the number of days, there is 7·28 feet for the mean of 15 years; the mean height of each month was given, and the table shows that the melting of snows is not the prevailing cause of high water. The highest freshets are recorded as far back as 1712. One of 1843 passed through 71·3 miles in 24 hours, showing a velocity of 4·16 feet per second, or one-half the velocity proper of the river. It would seem that the velocity of propagation of a freshet depends on its being instantaneous, rather than upon its elevation.

Every two or three years the navigation is impeded by floating ice, though the river is rarely frozen over, and but once between 1833 and 1848; on the breaking up, many lines of work, not well grounded, were overthrown, and some piles sawed and cut in two by ice. Thermometrical observations were made at the request of M. Prouy, the seven hours of morning, at noon, and seven hours of night; they were only continued from December until May, when the instruments were broken. From these it appears that at night and morning the water is warmer than the air, and the reverse at noon; that in the nights of winter months the water does not grow cooler, while in the spring it is 1·5° (Cent.) cooler in morning than evening.

Delivery.—A great number of gaugings were made with Woltmann's mill; in depths of 13 to 16 ft. the velocities were easily measured; in some freshets the velocity was measured in depths of 26 to 29 feet, though with considerable difficulty. In some places velocities were measured in 40 points upon a surface of 119 sq. yards. A table of 24 gaugings, with heights between 0·48 m. and 7·40 m., gave from 110 cubic metres up to 3664 cubic metres.

These results were co-ordinated by an empirical formula, similar to that of Lombardini for representing the delivery of the Po. Calling Q the delivery, h the height of water, and p the slope, the formula is

$$Q = m\,h\,\sqrt{p}.$$

m being a constant co-efficient for the same river.

For heights $h = 1{\cdot}40$ m.; 2·70 m.; 6·50 m.; 9.

The corresponding slopes per kilometre were

$$p = 0{\cdot}11 \qquad 0{\cdot}19 \qquad 0{\cdot}21 \qquad 0{\cdot}42;$$

which gives the relation,

$$p = -\,0{\cdot}094 + 0{\cdot}201\,h - 0{\cdot}044\,h^2 + 0{\cdot}003\,h^3.$$

Making $m = 125$, it represents to within $\frac{1}{20}$ the 17 deliveries, with heights below 6·4 m.; beyond that its results are too great. An inspection of the curve shows that with equal heights of water, the delivery is greater when the water rises than when it falls.

From this table we have the mean delivery per second for each month and year; the mean annual delivery from 1832 to 1847 was 863 yards per second, answering to a height of 2·36 m. Lombardini terms this quantity the *modulus* of a river, which for the Po was 2249 yards; the months of August and March answer as a mean to the maxima and minima of monthly delivery.

The mean volume per year, if supposed extended over a length of 34·7 miles and a breadth of 2·5 miles, would have a height of 305 ft., answering to a cube with a side of 3603 yards. The velocities increase with the height from 3·77 feet at 0·48 m. (Tonneins scale) to 10 feet at a height of 6·45 m.

Silt.—The silt, constantly held in suspension by the Garonne, is the great fertilizer of the rich vegetation teeming along its banks. Each day a quantity exactly measured was taken from the surface, allowed to settle from 8 to 10 days, decanted, and weighed; a number of ex-

periments, made with assortments from surface to a depth of 29 feet, shows an equal distribution, and warrants the application of the surface to the whole mass. Multiplying the weight of silt per cubic yard by the whole delivery, for the space of 8 years, there were 408 lbs. per second for a delivery of 1030 yards, or 0·39 lbs. per cubic yard. For the five years, from 1843 to 1848, when the deposits were somewhat greater, there was 0·47 lbs. per cubic yard; its mean density was 1·47, and 533 lbs. answers to a volume of 0·215 cubic yards; so that the total deposit per annum, well settled and dried, as a mean of five years, would give a cube of 226 yards a side, and would have risen on a plane of 34·7 miles by 2½ miles 0·076 feet.

Meteorological Observations.—On a comparison of annual heights of rain-fall from 1833 to 1846, which as a mean was 2·39 feet, with annual delivery of river, there is an evident correlation; and the great freshets for some time back upon the Loire and Rhone, must rather be attributed to the abundant rain-fall than to the clearing of the mountains. The end of the last century was more noted for high freshets upon the Garonne than later years, though there are more lets and hindrances from levees and dykes to the full sweep of floods, and though the mountains are more cleared and cultivated.

The volume of water delivered by the Garonne for 14 years, was 0·646 of the whole rain-fall.

(To be Continued.)

The Victoria Bridge at Pimlico.

From the London Engineer, No. 279.

It is rumored that both the roadway and the piers of this structure, completed a few months ago at a cost of nearly £100,000, are exhibiting signs of weakness. This bridge has, besides a number of short spans in the approaches, four wrought iron segmental arches of 175 ft. span each, there being three piers in the river. After the completion of the work, the piles, we believe, which had served as an enclosure to the piers, were withdrawn, leaving the foundations of the bridge exposed to the scour of the river. From the nature of the bottom, we should suppose that all the protection which the original piles (sawn off below water) could have given, would have been necessary. The arches themselves are formed each of six wrought iron plate ribs, arranged in three pairs, two pairs being placed so as to form the outsides of each span, while the other pair extends along the centre. These arched ribs are each about 4 ft. deep, and, perhaps, ½-in. thick, although they do not appear to the eye to be more than ⅜-in. thick. Flanches are riveted on both top and bottom. The spandrils are made of T-iron, riveted together in a sort of lattice-work. Over the spandrils, horizontal plate beams are placed, with their upper surfaces level with the crown of the arch, so as to complete the horizontal line of the roadway. The latter is carried upon rolled wrought iron cross beams, each about 11 ft. long, and 9 ins. deep, and spaced about 3 ft. apart. The ends of these beams abut

against the inner vertical surfaces of the arched ribs and horizontal beams over the spandrils. The fastening of these ends to the ribs is one of the most wretched "cobbles" to be found in bridge construction. First, a short piece of angle-iron, its upper horizontal surface forming a projecting shelf, about 4 ins. long and 3 ins. wide, is riveted by four rivets to the main arched rib (or to the horizontal beams over the spandrils). On this shelf, the end of the cross-beam rests. The form of this beam, in section, is like that shown in Messrs. Mather, Ledward, and Co.'s card in our advertising columns. Two short vertical lugs, formed also of angle-iron and riveted each by three rivets to the main rib, embrace the "stem" or thin vertical part of this beam. Through these lugs and the "stem" of the beam three rivets are inserted. The ends of the beams, therefore, hang by three rivets besides resting on the short projecting flanch of a fragment of angle-iron below. Instead of buckle-plates, blocks of creosoted wood are wedged between the cross-beams, and over these is the ballast and permanent way.

MECHANICS, PHYSICS, AND CHEMISTRY.

On the Composition of Cast Iron and Steel. By M. E. Fremy.

From the London Chemical News, No. 74.

I have already shown* that iron, cast iron, and steel do not appear to me to be allied, in relation to their composition, as is generally admitted; and it is not correct to say that steel is simply a combination of iron and carbon less carburetted than that forming cast iron.

Without absolutely denying the influence exercised by carbon on the properties of steel and cast iron, I purpose nevertheless to show that several other metalloids possess the property of greatly modifying the characteristics of cast iron and steel, and that these bodies do not exist accidentally in these compounds; and that all the uncertainty connected more especially with the manufacture of steel may probably be traced to the action, hitherto little studied, of foreign bodies.

The object of the experiments which I now make known is to determine the conditions under which nitrogen can combine with iron.

Every chemist is aware that to M. Despretz we owe the important discovery of nitride of iron; to him we owe the demonstration that iron, at red heat, decomposes ammoniacal gas, fixes the nitrogen, becoming itself white and brittle, and augmenting in weight, sometimes to the extent of 11·5 per cent. Submitted to the action of acids, this body produces a salt of iron and an ammoniacal compound.

These clear results have, however, been doubted by some chemists. Some have thought the increase in the metal's weight was owing to an oxidation produced by the water or air which ammoniacal gas is capable of retaining; others, that the modifications of the physical properties of the iron were due to an alternate phenomenon of the oxidation

* See Jour. Frank. Inst., 3d Series, Vol. xli., p. 239.

of the metal and the reduction of the oxide by the hydrogen of the ammonia.

Though convinced that the experiments of M. Despretz have no need of confirmation, I wished, however, to repeat the contested experiments in eliminating all sources of error which could arise from impurity in the ammonia or the humidity of the gas. I feel it incumbent upon me to state that every trial has completely confirmed M. Despretz's position. In numerous experiments I have invariably seen red-hot iron decompose ammoniacal gas, producing the brilliant white body called "nitride of iron" by M. Despretz.

The opinion has been advanced that the product of the decomposition of ammonia by iron might be a combination of metal with a hydride of nitrogen less hydrogenated than ammonia.

This question must be decided by experience. In fact, under the influence of oxygen, the compound studied by M. Despretz produces peroxide of iron. In conducting this decomposition in a porcelain tube, communicating with the tubes designed to fix the water produced by the reaction, it is easy to distinguish whether the compound was a nitride or an amidide of iron.

This experiment has been made with the greatest care. A known weight of the nitrogen compound was made red-hot in a current of oxygen, the metal was transformed into pure peroxide of iron, nitrogen was disengaged, and the tubes for absorbing the water underwent no alteration in weight. This experiment appears to me conclusive, and proves that the body produced by the action of ammoniacal gas on iron is actually nitride of iron, and that it contains no hydrogen.

This essential point being once established, it became necessary to determine under what other circumstances iron would combine with nitrogen.

I have first examined the action of pure nitrogen on metallic iron. The nitrogen was obtained either by decomposing nitrite of ammonia, or by the action of copper on atmospheric air, and the gas was purified and dried by the most efficacious means. It results from these experiments that nitrogen combines with great difficulty with the iron prepared by the processes usually employed in manufacture, but that it unites with the metal when presented to it in a nascent state. Thus, I have obtained nitrogenized iron by making nitrogen impinge on the oxide of iron at the moment of its reduction by either hydrogen or charcoal.

Cyanogen also modifies the properties of iron; but I have reserved the study of this reaction for another paper, to be devoted to the study of the phenomena resulting from the combined action of nitrogen and carbon on iron.

The processes to which I am about to refer doubtless yield nitride of iron, but the reactions are slow and incomplete. Thus, completely to nitrogenize small fragments of iron wire by ammonia, I have been obliged to pass the current of gas over the red-hot metal for three entire days.

In order to submit nitride of iron to a thorough chemical examina-

tion, and, above all, to study what influence this body is capable of exercising on the constitution and properties of steel, I have been obliged to devise a new method, which enables me to prepare this metallic nitride with facility. I have been so fortunate as to arrive at this result by decomposing at red heat protochloride of iron by dry ammoniacal gas. I introduced into a porcelain tube about 200 grammes of anhydrous protochloride of iron. This tube I made ret-hot, and passed over the salt a current of ammoniacal gas, furnished by ordinary liquid ammonia, slightly heated, the gas being dried by passing through long tubes filled with caustic potash.

Under the influence of ammoniacal gas the metallic chloride decomposes rapidly; chloride of ammonium and a curious amide salt are disengaged. This salt is instantly decomposed by water, producing ammonia and oxide of iron. After the operation an inflated and partly melted mass is found in the tube; it is sometimes gray, and often also metallic, white, and brilliant. This body is nitride of iron.

I submit to the inspection of the Academy about 200 grammes of nitride of iron obtained in this way. This body, till now hardly known to chemists, can henceforth be prepared with the greatest facility. It will, I have no doubt, become a new and valuable adjunct to our researches, by furnishing nitrogen to mineral substances or organic bodies. This process for the production of nitride of iron applies to the preparation of other metallic nitrides. By the same method I have obtained combinations of nitrogen with the metals of the iron group. A special paper will be devoted to these compounds.

I have proved that nitride of iron, proceeding from the decomposition of protochloride of iron by ammoniacal gas, possesses all the properties of that obtained by passing ammoniacal gas on red-hot iron.

This nitride is easily reduced to powder; it is less oxidizable than pure iron; it is very slowly attacked by nitric acid, but very speedily by sulphuric and by hydrochloric acids.

Nitride of iron when dissolved in acids produces ammoniacal and ferruginous salts.

According to the experiments made at my request by M. E. Becquerel, nitride of iron becomes magnetized readily and permanently like steel, only this property appears less developed than in ordinary steel.

Nitride of iron is remarkable for its fixity, and, in this respect, is allied to nitride of titanium, which has been so carefully studied by MM. Wöhler and H. Deville; in fact, it may be made red-hot without undergoing decomposition. Oxygen attacks it only at a high temperature, and then transforms it into peroxide of iron.

Nitride of iron, when heated in a charcoal fire, undergoes an important modification, to which I must revert when treating of the chemical constitution of steel. It is transformed, in this case, into a metallic mass analogous to steel, and, like it, becoming very hard by tempering. If nitrogen is present in this new compound, it does not exist in the same state as in nitride of iron; for when the hardened product is heated in a hydrogen current no trace of ammonia is disengaged.

The most remarkable reaction of nitride of iron is that which it exercises on hydrogen. When slightly heated in this gas it decomposes immediately, yielding ammonia, and leaving a residue of pure iron.

This direct combination of hydrogen with the nitrogen contained in a metallic nitride appears to me a very curious fact. It, however, proves that nitride of iron can be employed to yield nitrogen to other compounds. The easy decomposition of nitride of iron by dry hydrogen has enabled me to determine the different circumstances in which iron can unite with nitrogen. This experiment, in fact, removes all doubt.

It would be otherwise were the nitride attacked by an acid and the liquid then decomposed by potash. Reagents, and especially potash, often contain nitrates which, under the influence of protoxide of iron, produce ammonia.

The action also of hydrogen on nitride of iron has enabled me to analyze this compound readily. To determine the composition of nitride of iron, it is necessary only to estimate the loss this body undergoes when heated in dry hydrogen.

It results from my analyses that nitride of iron obtained by means of protochloride of iron contains 9·3 per cent. of nitrogen, this composition corresponding to a nitride represented by the formula Fe_5N. By making ammoniacal gas react on iron, M. Despretz has proved that the weight of the metal augments sometimes as much as 11·5 per cent.; the nitride formed in this case would be represented by Fe_4N.

I shall not now dwell upon the formula of nitride of iron, for there is no proof that this compound has yet been obtained in a state of absolute purity; the temperature at which it is formed and the hydrogen atmosphere then surrounding it are capable of varying its composition. It is, however, to be presumed that iron can unite with nitrogen in several proportions, as is shown by the following experiment:—Submit to the action of ammoniacal gas for twenty hours some small red-hot cylinders of pure iron, sufficiently large to render the chemical action incomplete, and the weight of the metal, under these circumstances, does not augment more than 6 per cent.

After this experiment, the metallic cylinders, when examined, will be found to be composed of two very different parts: the external one almost melted, exceedingly friable, and may be detached by the slightest blow; the other, internal, rather hard, and still metallic. The external part is formed of 9·8 per cent. of nitrogen and 90·2 per cent. of iron, corresponding to the formula Fe_5N. Thus, the nitride produced by the action of ammoniacal gas in excess on iron has the same composition as that resulting from the decomposition of protochloride of iron by ammonia. The internal and still metallic portion can be cut by a file; it is, nevertheless, very brittle, and contains nitrogen, but in much smaller proportion than in the preceding. It presents, in its general aspect, a certain analogy with metal called in the foundries burnt iron.

It would be a curious circumstance to ascertain whether this acci-

dent of its manufacture which deprives iron of all its useful properties is not owing to a combination of iron and nitrogen. This is a point not to be neglected in my future researches.

Such are the new facts relative to the history of nitride of iron which I wish to make known to the Academy. I will sum them up in a few words:—

1. The object of my first experiments was to reproduce and prove the exactness of the experiments M. Despretz has described in his paper on nitride of iron.

2. I then established the fact that the body produced by the reaction of ammoniacal gas on red-hot iron is really nitride of iron, and not of amidide; it contains no hydrogen.

3. It results from my experiments that the direct combination of nitrogen and iron takes place chiefly when the metal is in a nascent state.

4. I have proved that nitride of iron is formed with the greatest facility by decomposing anhydrous protochloride of iron by ammoniacal gas. This method applies to the preparation of other metallic nitrides.

5. The composition of nitride of iron prepared by the action of ammoniacal gas either on iron or on protochloride of iron, is the same; it contains about 9·5 per cent. of nitrogen, and may be represented by the formula Fe_5N.

6. Nitride of iron is completely modified when heated in a charcoal fire; is no longer decomposed by hydrogen; and appears to resemble steel.

In another Memoir I shall ascertain whether nitride of iron can be employed in the preparation of steel.—*Comptes Rendus.*

For the Journal of the Franklin Institute.

Strength of Materials: Deduced from the latest experiments of Barlow, Buchanan, Fairbairn, Hodgkinson, Stephenson, Major Wade, U. S. Ordnance Corps, and others. By Chas. H. Haswell, Civil and Marine Engineer.

No. 9.

(Continued from vol. xli, page 408.)

Torsional and Detrusive Strength.

Torsional Strength.

The torsional strength of any square bar or beam is as the cube of it side, and of any cylinder as the cube of its diameter. Hollow cylinders or shafts have greater torsional strength than solid ones containing the same volume of material.

The torsional angle of a bar, &c., under equal pressures will vary as the length of the bar, &c. Hence, the torsional strength of bars of like diameters are inversely as their lengths.

The strength of a cylindrical prism compared to a square is as 1 to ·85.

When a bar, beam, &c., having a length greater than its diameter,

is subjected to a torsional strain, the direction of the greatest strain is in the line of the diagonal of a square, and if a square be drawn on the surface of the bar, &c., in its primitive form, it will become a rhombus by the action of the strain.

TABLES OF THE TORSIONAL STRENGTH OF MATERIALS.

Deduced from the Experiments of Major Wade, U. S. A., and Reduced to an Uniform Measure of

One Inch Square or in Diameter, Weight or Stress applied at one foot in Length from Centre of Axis of the Material, and at the Face of the Axis or Journal.

SECTION OF FIGURE.	Side (S).	External diameter.	Internal diameter.	Length of journal, or part acted on.	Area of section.	Breaking weight of figure.	Breaking weight per inch, diameter or side.
	Inch.	Inch.	Inch.	Inch.	Sq. inch.	lbs.	$W \div S^3$
Square,	1·	1·		3·	1·	730	730
"	1·415	1·415		3·55	2·	1916	677
"	1·750	1·750		4·80	3·	4500	839
Cylinder,	1·135			3·	1·	896	613
"	1·595			3·60	2·	2790	687
"	1·955			4·80	3·	4750	636
							$W \div (S^3 - S'^3)$
Hollow cylinder,		1·300	·650	3·35	·995	1083	564
" "		1·811	·906	3·60	1·012	3104	597
" "		2·261	1·280	4·60	1·931	5104	540
" "		1·415	·839	5·60	1·967	1302	580
" "		2·211	1·544	5·75	2·728	4125	579
" "		3·250	2·605	8·00	2·926	7916	475

Summary of Preceding Results.

Area of cross section.	Breaking weight of figures.					
	Square $b\ d^2$.	Cylinder d^3.	Area of section.	Hollow cylinder $d^3 - d'^3$.	Area of section.	Hollow cylinder $d^2 - d'^2$
Inch.	lbs.	lbs.	Inch.	lbs.	Inch.	lbs.
1	730	613	·995	563	1·012	585
2	677	698	1·931	597	1·967	579
3	840	636	2·728	540	2·966	476
Mean,	749	649		567		547

All of the bars were from the same mixture of common foundry iron, of a mean torsional strength of 644 lbs. per square inch of section.

From these results it appears that solid square shafts have about one-fifth less strength than solid cylinders of equal areas.

The stress which will give a bar a permanent set of $\frac{1}{2}°$, is about $\frac{7}{10}$ths of that which will break it, and this proportion is quite uniform, even when the strength of the material may vary essentially.

The strongest bars give the longest fractures.

Wrought iron, compared with cast iron, has equal strength under a stress which does not produce a permanent set, but this set commences under a less force in wrought iron than cast, and progresses more rapidly thereafter. The strongest bar of wrought iron acquired a permanent set under a less strain than a cast iron bar of the lowest grade. The mean *values* of cast and wrought iron and bronze, for bars of small diameters for a permanent set of $\frac{1}{2}°$, are as 1·, ·6, and ·33.

TABLE *of the Torsional Strength of Cast and Wrought Iron and Bronze, with their Values for different Diameters.*

Length of Journal, or of the Bar or Beam submitted to strain, for which the Values are given, three times the Diameter or Side of the Shaft.

FIGURE.	Specific gravity.	Length of journal or side.	Breaking weight.	*Value* for diameter of			
				2 ins.	5 ins.	10 ins.	15 ins.
		Inch.	lbs.				
CYLINDER. CAST IRON.							
Good common castings,	7·180	8·	583	170	115	105	100
" cold blast,							
mean of 8 trials,	—	8·	705	175	120	110	105
Gun iron, small bars,	7·320	8·	750	190	130	120	115
greatest extreme,	7·724	8·	883	200	135	125	120
CYLINDER. WROUGHT IRON.							
Begins to yield, permanent set,	7·855	8·	300	130	128	125	123
Bends without breaking,	—	8·	642				
CYLINDER. BRONZE.							
Begins to yield, permanent set,	8·710	8·	192	55	45	35	33
Bends without breaking,	—	8·	458				
SQUARE. CAST IRON,	7·200	3·	730	220	150	140	134
"	—	4·8	840				
" WROUGHT IRON,	7·855	3·	—	170	165	160	162
HOLLOW CYLINDER. "							
Diameters, 1·3 and ·65,	—	3·35	1083	163	110	100	96
" 2·26 " 1·28,	—	4·60	5104	153	105	96	92
" 3·25 " 2·60,	—	8·	7916	135	90	85	80

The experiments above given were made with bars not exceeding 2 inches in diameter; the relations given, therefore, do not hold, as the diameters are increased, in consequence of the shrinking of the cast metals in cooling, which by cooling at the outer surface first, draws the metal from the centre and in effect gives to a bar or shaft the properties of a hollow cylinder. In shafts of 10 inches in diameter, the torsional strength of wrought iron is considered fully equal to that of cast iron, and with larger diameters it would be much greater but that it suffers deterioration as its diameter increases, from the increased difficulty in effecting welding and the reduction of the metal to a fibrous texture.

The following rules in all instances are purposed to apply to the diameters of the journals of shafts, or to the diameter or side of the bearings of the beams, &c., where the length of the journal or the distance upon which the strain bears, does not greatly exceed the diameter of the journal or side of beam, &c., *hence*, when the length or distance is greatly increased, the diameter or side must be correspondingly increased.

To ascertain the Torsional Strength of Square or Round Shafts, &c.

RULE.—Multiply the *value* in the preceding tables by the cube of the side or of the diameter of the shaft, &c., and divide the product by the distance from the axis at which the stress is applied in feet; the quotient will give the resistance in pounds.

EXAMPLE.—What torsional stress may be borne by a cast iron shaft of the best material, 2 inches in diameter, the power being applied at 2 feet from its axis?

$$125 \times 2^3 = 1000 \text{ and } \frac{1000}{2} = 500 \text{ lbs.}$$

To ascertain the Diameter of a Square or Round Shaft, &c., to resist Torsion.

RULE.—Multiply the extreme of pressure on the crank pin, or at the pitch line of the pinion, or at the centre of effect on the blades of the wheel, &c., that the shaft may at any time be subjected to, by the length of the crank or radius of the wheel in feet, &c.; divide their product by the *value* in the preceding tables, and the cube root of the quotient will give the diameter of the shaft or its journal in inches.

EXAMPLE.—What should be the diameter for the journal of a wrought iron water-wheel shaft, the extreme pressure on the crank pin being 59,400 lbs. and the crank 5 feet in length?

$$\frac{59400 \times 5}{125} = 2376 \text{ and}$$

$$\sqrt[3]{2376} = 13{\cdot}34 \text{ ins.}$$

When two Shafts are used, as in Steam Vessels with one engine, &c.

RULE.—Divide three times the cube of the diameter for one shaft by four, and the cube root of the quotient will give the diameter of the shaft in inches.

EXAMPLE.—The area of the journal of a shaft is 113 inches, what should be the diameter, two shafts being used?

Diameter for area of 113=12.

$$\text{Then } \frac{3 \times 12^3}{4} = 1296 \text{ and } \sqrt[3]{1296} = 10{\cdot}9 \textit{ ins.}$$

NOTE.—The examples here given are deduced from instances of successful practice; where the diameter has been less, fracture has almost universally taken place, the strain being increased beyond the ordinary limit.

2. When the work to be performed is of a regular character and the stress is consequently uniform, the proportion of $\frac{3}{4}$ths may be reduced to $\frac{5}{8}$ths.

Relative values of Cast and Wrought Iron.

When shafts of less diameter than 12 inches are required the *values* here given may be slightly reduced, according to the quality of the iron and the diameter of the shaft to be used; but when they exceed this diameter, the *values* may not be increased in a like manner, as the strength of a cast or a wrought iron shaft decreases as their diameters increase.

Grier makes the difference between cast and wrought iron shafts for all diameters as ·963 to 1·000.

To ascertain the Torsional Strength of Hollow Shafts and Cylinders.

RULE.—From the fourth power of the exterior diameter subtract the fourth power of the interior diameter and multiply the remainder by the *value* of the material; divide this product by the product of the ex-

terior diameter and the length or distance from the axis at which the stress is applied in feet: the quotient will give the resistance in pounds.

EXAMPLE.—What torsional stress may be borne by a cast iron hollow shaft, having diameters of 3 and 2 inches, the power being applied at 1 foot from its axis?

$$3^4 - 2^4 \times 105 = 81 - 16 \times 105 = 6825,$$

$$\text{which} \quad \div 3 \times 1 = \frac{6825}{3} = 2275 \textit{ lbs.}$$

The order of journals of shafts, with reference to the degree of torsional strength to which they are subjected, is as follows:—

1. Fly-wheel shafts.
2. Water-wheel shafts.
3. Secondary shafts.
4. Tertiary shafts, &c., &c.

Hence, the diameters of their journals may be reduced in this order.

Relative Value of Different Materials to Resist Torsion. By English Authors.

MATERIALS.		VALUE.	MATERIALS.		VALUE.
Cast Iron,	1·00	112	Brass,	·28	31
Wrought Iron,	1·12	125	Copper,	·25	28
do Swedish	1·05	117	Tin,	·15	17
Cast Steel,	2·17	243	Lead,	·11	12
Shear do,	1·88	210	Oak,	2·24	250
Blistered do,	1·84	206	White Pine,	2·05	228
Gun Metal (bronze),	·33	37			

Relative Value of Different Figures to Resist Torsion, Having Equal Sectional Areas.

Solid Cylinder.	Solid Square.	Hollow Cylinders, the interior and exterior diameters of which are in the proportion of				
		4 to 10.	5 to 10.	6 to 10.	7 to 10.	8 to 10.
1·000	·8750	1·2656	1·4433	1·7000	2·0864	2·7377

Detrusive Strength.

The Detrusive strength of any body is directly as its depth or thickness.

Table of the Results of Experiments upon the Detrusive Strength of Metals.

MATERIALS.	Diameter of shear or punch.	Thickness of metal.	Power exerted.	Power required for a surface of one square inch, viz:— 1 inch in depth, and 1 inch in width.
	Inch.	Inch.	lbs.	lbs.
Wrought Iron,	·5	·08	6,025	45,000
	·5	·17	11,950	
	·5	·24	17,100	
Copper,	·5	·08	3,983	30,000
	·5	·17	7,823	
Steel,	·5	·25	34,720	90,000
Fir,	·32	1·	600	600

NOTE.—The free use of oil reduces the power required very materially.

Comparison between Detrusive and Transverse Strengths.

Assuming the compression and abrasion of the metal in the application of a punch of one inch in diameter to extend to one-eighth of an inch beyond the diameter of the punch, the comparative resistance of wrought iron to *detrusive* and *transverse* strain, the latter estimated at 600 lbs. per square inch, for a bar one foot in length, is as 2·5 to 1.

Character of Strains to which Connecting Rods, Straps, Gibs, and Keys are subjected.

Heads of Rods.—At sides of keyholes, tensile and compressive; at back of keyholes, detrusive.

Straps.—At crown and sides of keyhole, tensile; at back of keyholes, detrusive.

Gib.—Transverse, uniformly loaded along its length, fixed at both ends.

Key.—With single gib, transverse, uniformly loaded along its length, supported at both ends.

Key.—With double gib, transverse, uniformly loaded along its length, fixed at both ends.

Woods.

When a Beam or any piece of wood is let in (not mortised) at an inclination to another piece, so that the thrust will bear in the direction of the fibres of the beam that is cut, the depth of the cut *at right angles to the fibres*, should not be more than one-fifth of the length of the piece, the fibres of which, by their cohesion, resist the thrust.

To ascertain the Force necessary to Punch Iron or Copper Plates.

Rule.—Multiply the product of the diameter of the punch and the thickness of the metal by 150,000 if for wrought iron, and by 96,000 if for copper, and the product will give the power required, in pounds.

(To be Continued.)

For the Journal of the Franklin Institute.

Strength of Cast Iron and Wrought Iron Pillars: A series of Tables deduced from several of Mr. Eaton Hodgkinson's Formulæ, showing the Breaking Weight and Safe Weight of Cast Iron and Wrought Iron Uniform Cylindrical Pillars. By Wm. Bryson, Civ. Eng.

(Continued from page 396, vol. xli.)

Tables showing the calculated breaking weight and safe weight of uniform solid cylindrical pillars of cast iron, and the calculated weight of metal contained in each pillar.

Formula for the breaking weight of solid pillars of cast iron, their length or height exceeding 25 times their diameters, both ends of the pillars being flat and firmly fixed:—

$$W = 44{\cdot}16 \frac{D^{3.55}}{L^{1.7}}.$$

The following formulæ, although not given by Mr. Hodgkinson, are applicable for the safe weight of solid pillars of cast iron, the length or height of the pillars exceeding 25 times their diameters.

For the safe weight, both ends of the pillars being flat and firmly fixed,

$$w = 11{\cdot}04 \frac{D^{3.55}}{L^{1.7}}.$$

For the safe weight, if irregularly fixed,

$$w = 4{\cdot}416 \frac{D^{3.55}}{L^{1.7}}.$$

NOTE.—The co-efficient 4·416 in this formula is, perhaps, rather too low.

Solid Uniform Cylindrical Pillars of Cast Iron, Both Ends being Flat and Firmly Fixed.

Length or height of Pillar in feet.	Number of diameters contained in the length or height.	Diameter in inches.	Calculated weight of metal contained in the Pillar in lbs.	Calculated breaking weight in tons from formula, $w = 44{\cdot}16 \frac{D^{3.55}}{L^{1.7}}$.	Calculated breaking weight in tons from formula, $r = \frac{bc}{b + \frac{2}{3}c}$.	Safe weight in tons.	Safe weight if irregularly fixed, in tons.
5	30	2	49·13	33·52		8·38	3·35
6	36	"	58·95	24·58		6·14	2·45
7	42	"	68 78	18·91		4·72	1·89
8	48	"	78·61	15·07		3·76	1·50
9	54	"	70·43	12·34		3·08	1·23
10	60	"	98·26	10·31		2 57	1·03
11	66	"	108·08	8·77		2·19	0·87
12	72	"	117·91	7·56		1·89	0·75
13	78	"	127·74	6·60		1·65	0·66
14	84	"	137·56	5·82		1·45	0·58
15	90	"	147·39	5·17		1·29	0·51
16	96	"	157·22	4·64		1·16	0·46
17	102	"	167·04	4·18		1·04	0·41
18	108	"	176·87	3·79		0·94	0·37
19	114	"	186·69	3·46		0·86	0·34
20	120	"	196·52	3·17		0·79	0·31
5	24	2½	76·77		69·99	17 49	6·99
6	28 8	"	92·12	54·32		13·58	5·43
7	33·6	"	107·47	41·79		10·44	4·17
8	38·4	"	122·83	33·30		8·32	3·33
9	43·2	"	138·18	27·26		6·81	2·72
10	48	"	153·54	22·79		5·69	2·27
11	52·8	"	168·89	19·38		4·84	1·93
12	57·6	"	184·24	16·71		4·17	1·67
13	62·4	"	199·60	14·59		3·64	1·45
14	67·2	"	214·95	12·86		3·21	1·28
15	72	"	230·31	11·44		2·86	1·14
16	76·8	"	245·66	10·25		2·56	1·02
17	81·6	"	261·01	9·24		2 31	0·92
18	86·4	"	276·37	8·39		2·09	0·83
19	91·2	"	291·72	7 65		1·91	0·76
20	96	"	307·08	7·01		1·75	0·70

Solid Uniform Cylindrical Pillars of Cast Iron, Both Ends being Flat and Firmly Fixed.

Length or height of Pillar in feet.	Number of diameters contained in the length or height.	Diameter in inches.	Calculated weight of metal contained in the Pillar in lbs.	Calculated breaking weight in tons from formula, $w = 44{\cdot}16\frac{D^{3{\cdot}55}}{L^{1{\cdot}7}}$.	Calculated breaking weight in tons from formula, $T = \frac{bc}{b + \frac{1}{4}c}$.	Safe weight in tons.	Safe weight if irregularly fixed, in tons.
5	20	3	110·55		122·08	30·52	12·20
6	24	"	132·66		98·83	24·70	9·88
7	28	"	154·77	79·81		19·95	7·98
8	32	"	176·88	63·60		15·90	6·36
9	36	"	198·99	52·06		13·01	5·20
10	40	"	221·11	43·52		10·88	4·35
11	44	"	243·22	37·01		9·25	3·70
12	48	"	265·33	31·92		7·98	3·19
13	52	"	287·44	27·86		6·96	2·78
14	56	"	309·55	24·56		6·14	2·45
15	60	"	331·66	21·84		5·46	2·18
16	64	"	353·77	19·57		4·89	1·95
17	68	"	375·88	17·65		4·41	1·76
18	72	"	397·99	16·02		4·00	1·60
19	76	"	420·10	14·61		3·65	1·46
20	80	"	442·22	13·39		3·34	1·33
5	17·142	3½	150·49		192·70	48·17	19·27
6	20·571	"	180·58		158·62	39·65	15·86
7	24	"	210·68		132·32	33·08	13·23
8	27·428	"	240·78	109·95		27·48	10·99
9	30·859	"	270·88	90·00		22·50	9·00
10	34·285	"	300·98	75·24		18·81	7·52
11	37·714	"	331·07	63·99		15·99	6·39
12	41·142	"	361·17	55·19		13·79	5·51
13	44·571	"	391·22	48·17		12·04	4·81
14	48	"	421·37	42·46		10 61	4·24
15	51·428	"	451·47	37·76		9·44	3·77
16	54·857	"	481·56	33·84		8·46	3·38
17	58·284	"	511·66	30·52		7·63	3·05
18	61·714	"	541·76	27·70		6 92	2·77
19	65·142	"	571·86	25·26		6·31	2·52
20	68·571	"	601·96	23·15		5·78	2·31
5	15	4	196·55		282·98	70·74	28·29
6	18	"	235·86		236·53	59·13	23·65
7	21	"	275·17		199·68	49·92	19·96
8	24	"	314·48		170·35	42·58	17·03
9	27	"	353·79	144·58		36·14	14·45
10	30	"	393·10	120·87		30·21	12·08
11	33	"	432·41	102·79		25·69	10·27
12	36	"	471·72	88·66		22·16	8 86
13	39	"	511·03	77·38		19·34	7·73
14	42	"	550·34	68·22		17·05	6·82
15	45	"	589·65	60·67		15·16	6·06
16	48	"	628·96	54·36		13·59	5·43
17	51	"	668·27	49·04		12·26	4·90
18	54	"	707·58	44·50		11·12	4·45
19	57	"	746·89	40·59		10·14	4·05
20	60	"	786·20	37·20		9·30	3·72

Solid Uniform Cylindrical Pillars of Cast Iron, Both Ends being Flat and Firmly Fixed.

Length or height of Pillar in feet.	Number of diameters contained in the length or height.	Diameter in inches.	Calculated weight of metal contained in the Pillar in lbs.	Calculated breaking weight in tons from formula, $w = 44{\cdot}16\frac{p^{3{\cdot}55}}{l^{1{\cdot}7}}$.	Calculated breaking weight in tons from formula, $y = \frac{b\,e}{b + \frac{1}{2}e}$.	Safe weight in tons.	Safe weight if irregularly fixed, in tons.
5	13 333	4½	248·77		393·64	98·41	39·36
6	16	"	298·52		333·64	83·41	33·36
7	18·666	"	348·27		284·84	71·21	28·48
8	21·333	"	398·03		245·20	61·30	24·52
9	24	"	447·78		212·86	53·21	21·28
10	26·666	"	497·54	183·62		45·90	18·36
11	29·333	"	547·29	156·15		39·03	15·61
12	32	"	597·04	134·68		33·67	13·46
13	34·666	"	646·80	117·55		29·38	11·75
14	37·333	"	696·55	103·63		25·90	10·36
15	40	"	746·31	92·16		23·04	9·21
16	42·666	"	786·06	82·58		20·64	8·25
17	45·333	"	845·81	74·49		18·62	7·44
18	48	"	895·57	67·60		16·90	6·76
19	50·666	"	945·32	61·66		15·41	6·16
20	53·333	"	995·08	56·51		14·12	5·65
5	12	5	307·13		525·14	131·28	52·51
6	14·4	"	368·55		450·75	112·68	45·07
7	16·8	"	429·98		388·84	97·21	38·88
8	19·2	"	491·40		337·58	84·39	33·75
9	21·6	"	552·83		295·11	73·77	29·51
10	24	"	614·26		259·78	64·94	25·97
11	26·4	"	675·68	226·98		56·74	22·69
12	28·8	"	737·11	195·77		48·94	19·57
13	31·2	"	798·53	170·87		42·71	17·08
14	33·6	"	859·96	150·64		37·66	15·06
15	36	"	921·39	133·97		33·49	13·39
16	38·4	"	982 81	120·05		30·01	12·00
17	40·8	"	1044·24	108·29		27·07	10·82
18	43·2	"	1105·66	98·26		24·56	9·82
19	45·6	"	1167·09	89·63		22·40	8·96
20	48	"	1228·52	82·15		20·53	8·21
5	10	6	442·26		851·39	212·84	85·13
6	12	"	530·71		746·79	186·69	74·67
7	14	"	618·76		656·17	164·04	65·61
8	16	"	707·61		578·56	144·64	57·85
9	18	"	796·06		512·41	128·10	51·24
10	20	"	884·52		456·04	114·01	45·60
11	22	"	972·97		407·91	101·97	40·79
12	24	"	1061·42		366·66	91·66	36·66
13	26	"	1149·87	326·40		81·60	32·64
14	28	"	1238·32	287·76		71·94	28·77
15	30	"	1326·78	255·92		63·98	25·59
16	32	"	1415·23	229·32		57·33	22·93
17	34	"	1503·68	206·86		51·71	20·68
18	36	"	1592·13	187·71		46·92	18·77
19	38	"	1680·58	171·22		42·80	17·12
20	40	"	1769 04	156 93		39·23	15·69

Hollow Uniform Cylindrical Pillars of Cast Iron, Both Ends being Flat and Firmly Fixed.

Length or height of Pillar in feet.	Number of diameters contained in the length or height.	External diameter in inches.	Internal diameter in inches.	Calculated weight of metal contained in the Pillar in lbs.	Calculated breaking weight in tons from formula, $w = 44{\cdot}34\,\frac{D^{3{\cdot}55} - d^{3{\cdot}55}}{L^{1{\cdot}7}}$.	Calculated breaking weight in tons from formula, $r = \frac{bc}{b + \frac{1}{4}c}$.	Safe weight in tons.
8	12	8	6½	427·52		530·06	132·51
9	13½	"	"	480·96		490·19	122·54
10	15	"	"	534·40		453·32	113·33
11	16½	"	"	587·84		419·48	104·87
12	18	"	"	641·28		388·57	97·14
13	19½	"	"	694·72		360·32	90·08
14	21	"	"	748·17		334·81	83·70
15	22½	"	"	801·61		311·54	77·88
16	24	"	"	845·05		290·39	72·59
17	25½	"	"	908·49		271·16	67·79
18	27	"	"	961·93		253·67	63·41
19	28½	"	"	1015·37		237·71	59·42
20	30	"	"	1068·81		223·15	55·78
21	31½	"	"	1122·25		209·84	52·46
22	33	"	"	1175·69	194·04		48·51
23	34½	"	"	1229·13	179·92		44·98
24	36	"	"	1282·57	167·36		41·84
25	37½	"	"	1336·01	156·14		39·03
26	39	"	"	1389·45	146·07		36·51
27	40½	"	"	1442·89	136·99		34·24
28	42	"	"	1496·33	128·78		32·19
29	43½	"	"	1549·78	121·32		30·33
30	45	"	"	1603·22	114·52		28·63
8	10⅔	9	7½	486·49		645·89	161·47
9	12	"	"	547·30		602·84	150·71
10	13⅓	"	"	608·11		562·33	140·58
11	14⅔	"	"	668·92		524·52	131·13
12	16	"	"	729·74		489·45	122·36
13	17⅓	"	"	790·55		457·04	114·26
14	18⅔	"	"	851·36		427·20	106·80
15	20	"	"	912·17		399·76	99·94
16	21⅓	"	"	972·98		374·54	93·63
17	22⅔	"	"	1033·80		351·38	87·84
18	24	"	"	1094·61		330·13	82·53
19	25⅓	"	"	1155·42		310·58	77·64
20	26⅔	"	"	1216·23		292·61	73·15
21	28	"	"	1277·04		276·07	69·01
22	29⅓	"	"	1337·85		260·82	65·20
23	30⅔	"	"	1398·67		246·76	61·44
24	32	"	"	1459·48	232·32		58·08
25	33⅓	"	"	1520·29	216·75		54·18
26	34⅔	"	"	1581·10	202·76		50·69
27	36	"	"	1641·91	190·17		47·54
28	37⅓	"	"	1702·73	179·46		44·86
29	38⅔	"	"	1763·54	168·41		42·10
30	40	"	"	1824·35	158·97		39·74

(To be Continued.)

Chronograph with Conical Pendulum. By M. MARTIN DE BRETTES. Constructed by M. HARDY; described by M. DESPRETZ.

This chronograph consists of a metallic cylinder covered by a band of paper. A platinum point is revolved around this cylinder by clock-work, the motion being regulated by a conical pendulum. It makes a turn in one second, and the spaces described are proportional to the times. Very small fractions of a second may be measured on this instrument, since the space described in a second is 75 centimetres (29½ inches). The point does not touch the paper, but an electric spark pierces the paper at each rupture of the circuit.

In using this apparatus in balistic experiments, a wire screen through which the ball passes is put into connexion with the inducing circuit, and placed at any desired point of the trajectory.

M. Despretz reminds us that many learned men have invented chronographs and chronoscopes, and he mentions a number of English, French, and Russians. It may not be improper to add to his list the names of Bond of Cambridge, Locke of Cincinnati, Sears Walker of Washington, who first applied the electric current to the registering of astronomical observations, and Prof. Henry of the Smithsonian Institution, who proposed the first application of it to balistic experiments.

Sulphur in Coal Gas.

From the London Engineer, No. 274.

Some attention has lately been directed to the fact of the existence of compounds of sulphur in coal gas used for illuminating purposes. In an interesting report upon the subject, by F. Versmann, F. C. S., it is pointed out by this chemist that, however desirable it may be to perfect the means for purifying gas, there is no occasion for any degree of alarm on the part of the public with regard to the amount in which the impurities in question exist, or their effect upon health. The means for determining the proposition of sulphur in gas are simple, and susceptible of great accuracy. The gas is burnt in atmospheric air contained in a close glass vessel, and in contact with a solution of ammonia. The products of combustion are further made to pass through two Woolf's bottles; the first containing a solution of ammonia, the second a solution of iodine in iodide of potassium. The latter solution was employed by Mr. Versmann in case some of the sulphurous acid resulting from the combustion should escape absorption by the ammonia; but it was found that not a trace of sulphur could be detected in the second bottle. The sulphurous acid, combined with ammonia, as sulphite of ammonia is converted into sulphuric acid by a solution of iodine in iodide of potassium, precipitated by chloride of barium, and weighed as sulphate of barytes.

The following table represents the results of the experiments according to this process:

First Series of Experiments, made at the Works of the Commercial Gas Company.

Commencement of the experiment.	Duration of experiment in hours.	Cubic feet of gas burnt.	Grains of $BaO.SO_3$ obtained.	Corresponding grains of sulphur.	Grains of sulphur calculated for 100 cubic feet of gas.	Mean of grains of sulphur calculated for 100 cubic feet of gas.
February 27, .	23	13	3·08	0·42	3·23	2·99
do 28, .	95	30	6·80	0·94	3·12	
March 5, . .	217	75	14·41	1·98	2·64	
do 14, . .	294	118	25·42	3·49	2·96	
May 17, . .	6	3·5	1·53	0·21	6·00	6·35
do 21, . .	4·5	2	0·98	0·134	6·70	

Second Series of Experiments, made at the Laboratory of F. Versmann, with Gas of the Chartered Gas Company.

March 27, .	4	5	3·50	0·48	9·60	9·41
do 28, .	9	14	10·60	1·46	10·43	
do 30, .	40	69	42·24	5·80	8·40	
April 4, . .	6	9	6·04	0·83	9·22	

In the experiments of Professor Hofmann, as detailed in a report to the Lords of the Committee of Privy Council on Education, the maximum amount of sulphur found in 100 cubic feet of gas is 10·33 grains. The variation in these results is in some measure explained by the fact that the formation of bisulphide of carbon greatly depends upon the following conditions:—1st, The dampness of the coals; because in very damp coals all sulphur will most probably be converted into sulphuretted hydrogen. 2d, The degree of heat to which the coals are exposed; and, 3d, Upon the quantity of sulphur present in the coals.

It is shown, however, by Mr. Versmann, that even the largest quantity of sulphur found in coal gas is comparatively so small that the difference becomes insignificant. Thus, according to the results obtained, 10,000 parts by weight of gas contain in three different samples, 1·2, 2·6, and 3·8 parts of sulphur respectively; or, if we compare the volume of the coal gas to those of the bisulphate of carbon, 10,000 parts by volume contain 0·236, 0·480, and 0·747 cubic feet respectively of vapors of bisulphide of carbon.

When the amount of carbonic acid gas produced by the combustion of coal gas is compared with that of the sulphurous acid gas resulting from the sulphur compounds, it becomes evident that the contam-

ination of the atmosphere of an apartment by the former agency must necessarily reach a very high point before any inconvenience or injury can be occasioned by the sulphurous acid. To whatever extent ventilation is employed, the deterioration of the air to a serious degree is to be apprehended long before the acid gas can exert any sensible action. With every 50,000 cubic feet of carbonic acid, 4·7, 10·12, or 14·8 cubic feet of sulphurous acid only would be formed from the gas of which samples were analyzed by Mr. Versmann. In this proportion, it could have no injurious effect upon the human constitution while ventilation was sufficiently active to remove the enormous proportionate volume of carbonic acid. The same quantity of sulphur would be burnt by lighting three, seven, or ten of the ordinary lucifer matches, as in the consumption of 100 cubic feet of gas containing 2·99, 6·35, or 9·41 grains of sulphur. These considerations may have the effect of removing any apprehensions of injury resulting from the presence of sulphur in gas, which may have been occasioned by the discussion on this subject.

Translated for the Journal of the Franklin Institute.

Artificial Madder.

M. Dumas announced to the Academy of Sciences of Paris, that M. Roussin had obtained *alizarine*, the coloring principle of madder, from naphthaline.

A mixture of bi-nitro-naphthaline with concentrated and pure sulphuric acid, is placed in a large porcelain capsule heated by an oil or sand-bath By raising the temperature, the bi-nitro-naphthaline dissolves completely in the sulphuric acid. When the mixture has reached 392° Fahr. granulated zinc is dropped into the mixture gradually, and with careful observation not to allow the temperature to rise much. In a few minutes a disengagement of sulphurous acid takes place, and the operation is terminated in about half an hour. If a drop of the acid liquid is then allowed to fall into cold water, a magnificent violet color is developed, due to *alizarine*.

When the reaction is over, the liquid is diluted with 8 or 10 times its volume of water and brought to the boiling-point, and after boiling a few minutes, thrown into a filter. The alizarine is deposited upon cooling as a red jelly, sometimes adhering to the vessels, sometimes suspended in the liquid. Examined by the microscope it is seen to be composed of needle-shaped crystals of great definiteness. The mother-waters are strongly red from dissolved alizarine, and may be used to dye directly. A quantity of alizarine remains in the filter, which may be removed by caustic alkalies.

In the preceding reaction the zinc may be replaced by any one of a number of substances, such as iron, mercury, sulphur, carbon, or in short, by any substance which reacts at a high temperature with sulphuric acid, with the production of sulphurous acid.

The substance thus obtained possesses all the characters and re-

actions of alizarine. It is but slightly soluble in water, but soluble in alcohol and ether. Volatilizes between 419° and 464° Fahr. with a yellow vapor, and gives deep red needle-shaped crystals, whose tone of color is very variable. It is not attacked by chlorhydric or concentrated sulphuric acid. It dissolves in caustic and carbonated alkalies with a deep blue purple color. Acids precipitate this solution in deep orange-red flocculi. Like alizarine from madder, it furnishes lakes of the most beautiful colors. It is fixed on stuffs like natural alizarine, and gives similar tints.

Nothing remains but to determine the composition of these two substances comparatively; until that is done their identity cannot be definitely affirmed.—*Cosmos.*

On the Welding of Malleable Iron. By JAMES NASMYTH, Esq., C. E.

From the Lond. Engineer, No. 271.

Of all the processes connected with the working of malleable iron, there is none that has a more intimate relation to the security of life and property than that of "welding," or the process by which we are enabled to unite together, in one mass, the several portions of malleable iron, of which the generality of works in that material are formed.

Every single link in a chain-cable, every wheel tyre in a railway train, directly owes its trustworthiness to the manner in which the process of welding has been performed, in so far as that any imperfection in one single member of the set of cable links or railway wheel tyres may involve a most fearful loss of life, of which, of late years especially, we have had such distressing and melancholy experience.

It is with the most earnest conviction of the vital importance of the process of welding, by reason of its close relation to the security of life and property, that I am anxious to offer a few remarks, based on long and intimate acquaintance with the process in question, and on those conditions that conduce to its perfect performance, which remarks I am fain to think, if read with due care and consideration by those who are more specially concerned with the practice of the process of welding iron, may in no small degree tend to render less frequent those fearful and distressing catastrophes of which recent records of ship and railway disasters furnish such sad evidence.

In order to render more clear the following remarks as to the cause, and most certain means of the prevention of defective welding, it may be as well, at the risk of a little tediousness, to explain the nature of the process of welding iron, which consists in inducing upon malleable iron, by means of a very high heat, a certain degree of adhesiveness, so that any two pieces of malleable iron, when heated to the requisite degree, will, if brought into close contact, adhere or stick together with a greater or less tenacity, according to the amount of force applied to urge them into close contact.

But as malleable iron, when heated to the high temperature requisite to induce the adhesive or weldable condition, is at the same time rendered highly oxidizable, the surface of the iron at the welding hot part becomes enveloped with a coat of vitrified oxide, which adheres

to the metal with great obstinacy; and although this molten oxide can be rendered more fluid, and the further oxidation in some degree restricted, by sprinkling the welding hot surface of the iron with sand, which, combining with the molten oxide, renders it more fluid, and, therefore, more easily removable from the surface of the iron, yet so rapid is the oxidation of the iron when at the high heat requisite for welding, that unless the utmost care be taken and some special means applied for the purpose, more or less of this vitrified oxide is certain to be shut up between the surfaces at the welded part, and a defective junction is the consequence, which defect (as is but too frequently the case), giving no external evidence of its existence, may develop itself in the most unexpected manner, and result in a fearful catastrophe.

It is, therefore, to the means of thoroughly expelling this vitrified oxide from between the surfaces of the iron where the welded junction is to take place that we must direct our attention, for so long as any portion of this adhesive viscid substance is permitted to exist and interpose itself between the surfaces we desire to unite by welding, no sound or trustworthy junction can take place, and once it has made a lodgment no after-heating or hammering, be it ever so severe, will cause its thorough expulsion. It is, therefore, to the thorough expulsion of the vitreous oxide in the first stage of the welding that we must direct the most careful attention, and it would, in no small degree, tend to bring to an end those fearful accidents of which defectively-welded iron-work is so fertile a cause, if all those who are specially and practically concerned with the superintendence of workmen entrusted with the performance of this vitally important process, would see to the use and practice of the truly simple means which I am about to describe.

Fortunately the means of securing a perfectly sound and trustworthy welding are as simple as they are effective, and if those who are entrusted with the superintendence of this vitally important process and of the workmen who perform it, would but give their earnest personal attention to see that the simple and common-sense mode of operation which I am about to describe were in every case attended to, we should bring to an end a fertile source of mischief and disaster.

As I have before said, the chief cause of defective welding arises from portions of the vitreous oxide of the iron being shut up between the surfaces at the part presumed to have been welded, and that besides the impossibility of ascertaining, in the majority of cases after the process of welding has been gone through, whether or not this vitreous oxide has been thoroughly expelled, and the surfaces at the welding brought into perfect metallic union, and that no after-heating or hammering can dislodge the vitreous oxide when once it has effected a lodgment.

Our best and only true security is to form the surfaces of the iron at the part where the welding is desired to take place, so that when applied to each other, when at the welding heat, *their first contact with each other shall be in the centre of each.* Fig. 1 will represent two such surfaces formed in such a manner as to come into contact with each

other in the centre of each, so that when they are urged into close contact by the aid of the hammers, a free escape and means of egress for the interposed matter, vitreous oxide, may be preserved to the last, as indicated in the figures given.

I think it will not require tedious or elaborate description from me to impress on the attention of all who are specially interested in this subject, the practical value of this common-sense and truly valuable, as well as simple, means of effecting the thorough expulsion of the vitreous oxide, as the mode I have pointed out is not only in the highest degree simple and effective, but is also capable of application in every case in which this vitally important process of welding is requisite in the formation of works in malleable iron.

Fig. 1.

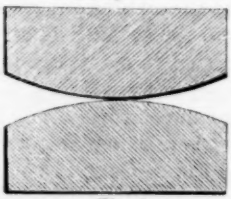


Fig. 3.

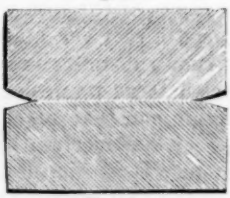


Fig. 5.

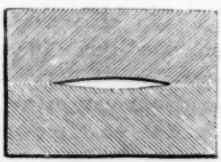


Fig. 2.

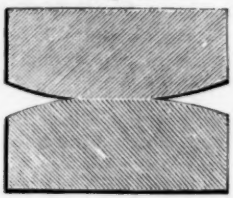


Fig. 4.

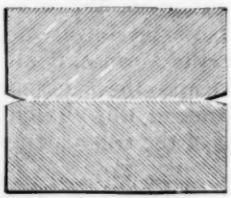
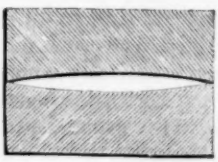


Fig. 6.



In order still further to impress on the attention the distinctive characters and value of this simple means of getting quit of the most fertile cause and source of defective welding and its but too frequent fatal consequences, I may as well give a figure of the form of the surfaces of iron-work, as frequently prepared for welding by workmen who are not intelligently alive to the importance of thoroughly dislodging the vitreous oxide from between the surfaces of the parts desired to be welded. Such ignorant or negligent formation of the surfaces is but too frequently made of the nature as indicated in Fig. 5, namely, they are allowed to assume a concave in place of a convex form, and the consequence of such is, that when these surfaces are brought together at a welding heat, and their cohesion aided by the action of the hammers, after the first splash of vitreous oxide is drawn forth by the few first blows of the hammers, the residue remains behind so effectually shut up that no after heating or hammering will ever expel it, and the work resulting will be, in consequence, charged with mischief and fatal disaster, and that all the more dangerously so inasmuch as that the welding of such *concave* surfaces will, from having taken place at the outside part, present all the outward aspect of perfect soundness, as seen in Fig. 6.

Unfortunately, it does happen sometimes that, owing to the simplicity and obviousness of certain improvements in the processes connected with practical matters of the class in question, they do not receive that degree of notice and earnest attention that is given to more elaborate, complex, and "scientific-looking" so-called improvements.

I trust, however, that a consideration of the intimate connexion which the process of welding has with the security of life and property will obtain, for the common-sense means which I have detailed for averting those sad catastrophes which but too often are the direct result of the defective welding of iron, that degree of careful and earnest attention which, I doubt not, every intelligent practical man will give to them.

The Adriatic.

From Mitchell's Steam-Shipping Journal, No. 85.

The steamship *Adriatic*, Captain Jefferson Maury, which arrived here on Sunday morning from New York, and is now the property of the Atlantic Royal Mail Company, was taken to Stokes Bay to-day for an official trial trip before entering on the mail service under the British flag. She made four runs on the measured mile with the following results:—First run, 4 min. 31 sec., equal to 13·284 knots per hour; second, 3 min. 18 sec., or 18·181 knots; third, 4 min. 20 sec., or 13·846 knots; fourth, 3 min. 21 sec., or 17·910 knots; giving a mean speed of 15·908 knots per hour. Revolutions of engines during trial, 17 to 18; pressure of steam, 25 lbs.; vacuum, 25 lbs., with surface condensers. Draft of water, forward, 17 feet 2 ins.; aft, 18 feet 10 ins.; 113 tons of coal on board. The usual authorities of the Admiralty and the Board of Trade were present to witness the trial, together with some of the Company's officials, and a few other scientific gentlemen. The *Adriatic* goes into dry dock to be surveyed, and will leave for Galway in the course of a few days. This fine steamship has excited much attention among nautical men during the time she has been lying in our docks, her beautiful lines, as well as the extent and splendor of her internal arrangements, being much admired by all who have paid her a visit.

Southampton, March 27.

Photo-Sculpture.

M. François Willème proposes the following very ingenious application of the photograph to sculpture:

The model is placed in the centre of a circular platform, around which are arranged at equal heights a number of similar cameras; or around which, one camera can be moved so as to be placed in successive positions at the same distance from the model: in this way a considerable number of photographs are taken. Let us, for the sake of illustration, suppose four: the first, A, presenting the face view; B, the profile from the right; C, the back view; D, the profile from the

left. The material to be carved, which for the sake of simplicity we will suppose soft, is mounted on a circular platform whose circumference is symmetrically divided into as many parts as there are photographs. These photographs are mounted in frames adjusted in the same relative positions in which they were taken. A pantograph is then applied to the photograph A, and while one extremity traces the outlines, the other, provided with properly adjusted cutters, cuts out the face view from the block. The pantograph is then moved to the photograph B, and the right profile cut; and so on for the others. Of course four photographs would not be sufficient, but any even number may be taken, say twenty-four, and they are cut in such order as to cause each photograph to be succeeded by the one at right angles to it: thus, in the case of twenty-four photographs, the order will be 1, 7, 2, 8, 3, 9, &c. When these cuttings are finished, but little is left for the hand in rounding off the angles and finishing the contours, and an accurate representation of the original will have been furnished in an entirely mechanical way.—*Cosmos.*

Lime as a Protection for the Vine.

A correspondent of the *Cosmos* writes that he has succeeded in protecting his vines perfectly against the *öidium* by simply white-washing the plant and especially the new wood, wherever it appeared affected. He says that he has pursued this course for three years and with entire success.

Perhaps the experiment might be worth trying here in reference to other nuisances.—*Cosmos.*

Apparatus for Testing Silk.

From the Lond. Mechanics' Magazine, Dec., 1860.

This is an apparatus newly invented by M. Froment, for testing the tenacity and elasticity of silks of different sorts. The dynamometric portion of the apparatus is composed of a small, thin, and very flexible lamina of steel horizontally fixed in its centre. Its extremities are connected by two small rods to a single shaft rising to some height, and having its upper extremity finely split for the purpose of fixing the thread to be tested. When this thread is subjected to traction, it causes the lamina or spring above described to bend, and this motion is communicated to the hand of a dial-plate. When the thread snaps, this hand remains at the point to which it had been brought by the effect of the traction. The other portion of the apparatus by which the traction is effected, is a piece of clock-work which descends by its own weight. It is provided with a pair of pincers, into which the other end of the thread is inserted. By means of this apparatus, M. Persoz has been enabled to make experiments on the tenacity of various silks, the results of which he has communicated to the *Société Impériale d'Acclimatation.* Thus, the threads tested being all of the length of half a metre, M. Persoz shows that the tenacity of the Cal-

cutta cocoon is represented by 5·3, that of Teneriffe 5·2, while those from Avignon and Prussia were 12 and 12·9 respectively; that of Neuilly marked 8. The elasticity of these sorts per metre were respectively 9·9, 12·8, 14·4, 13·4, and 12·9. The following general conclusions derived from these experiments are interesting:—1. The male cocoon yields a finer and more tenaceous silk than the female one. 2. The same species reared on different soil and in different climates does not yield threads of the same tenacity. The latter fact, M. Persoz thinks, should induce the *Société d'Acclimatation* to undertake experiments for the sake of determining with precision the effects which soil and climate, as well as the kind of food, produce on the silk-worm.—*Galignani's Messenger.*

Velocity of Light.

M. Leon Foucault has finished an improvement on his rotating mirror, and is preparing to measure accurately by it the velocity of light. He hopes thus to determine the real distance of the Sun from the Earth, and to furnish M. Leverrier with a datum of which he has great need, in his theories of the Sun, Mercury, Venus, and Mars.—*Cosmos.*

On Plastic Wood. By Mr. Francis Steinitz.

From the Journal of the Society of Arts, Nos. 424, 425.

Sir—Observing in the last number of your Society's *Journal*, a short article on the above subject, extracted from a communication to the *Times* by its Paris correspondent, I venture to offer a few observations, which may prevent erroneous views from being taken in connexion with this invention.

I endeavored, about ten years ago, to produce ornamental plastic wood, by the application of pressure and softening the woods, and succeeded to a certain extent, by cold pressure, but without softening the wood; but, as I had anticipated, the "relief" was of very slight depth. Several kinds of wood are capable of being softened by boiling or steaming, (the process adopted for knife-cutting veneers and bending sticks, shafts, and other carriage and ship-building work,) but very few indeed can be sufficiently softened to replace the carving for furniture making. Those foreign woods which are figured by fibres, or various excrescences, or which have fibres traversing the annual rings, are by no means adapted for that purpose. Equally unsuitable are dark-colored woods, in which, even when the impression is successful, the outline of the "relief" is much less distinct than in light-colored ones. Of the latter, lime-tree, poplar, and willow might be used effectually so far as regards the sunk parts of the ornaments, which could easily be pressed into the softened wood, but it is very improbable that the raised parts, retaining the original soft nature of the wood, would ever become sufficiently hardened to resist the effects of time. To apply a chemical remedy would not only be costly, but also detrimental to the texture

and color of many woods, especially oak; the mere application of water or steam to oak will change the color from an agreeable pale-yellow to an unpleasant reddish hue.

Walnut is, indeed, susceptible of being easily softened; but although it is much liked in England for some descriptions of furniture, when it is richly figured, the plainer sorts would, on account of their dull color, probably meet with little favor for the imitation of carving.

Several East Indian, Chinese, and Brazilian woods might be named which, being soft as sponge, and yet fine-grained, are especially suitable for pressure, but they are all open, and even to a greater degree, to the objection which I have suggested against the use of the English light-colored woods. Such delicate carvings as are executed with the chisel by Mr. Rogers and other sculptors, can certainly not be produced by pressure; while if, as we may presume from the list of articles named by the inventor, only a shallow description of carving is aimed at, this can be executed with great nicety by the turning lathe on the "guilloche" system, frequently used for portraits in ivory and wood, and now very much applied to straw-colored coach-panels, imitating basket-work. But if the imitation of carving of a more raised character be wished for, I believe there is nothing so well adapted as leather ornaments, which have now been brought to an excellent state, and are not very expensive.

As everything connected with wood is in the highest degree interesting to me, I am anxious to obtain as much information as possible on any new invention relating to it; and hope these lines may give occasion to a closer investigation of the subject, which would be much facilitated if the inventor would forward a few specimens to your next Exhibition. The few which accompany this letter are the results of experiments made ten years ago, and were only intended for book-sides, but found no favor for that purpose.

London Parquetry Company, Camberwell.

The following additional information on this subject appears in the *Manchester Examiner*:—

One of the results of the late French treaty has been the introduction into this city of a new product of art and industry, called "bois duré," which will cause quite a revolution in the manufacture of many articles of ornament and general use, and, to judge by the remarkable applications that we have seen, the discovery is a great success. Bois duré, or hardened wood, which has been improperly described as wood softened and then hardened, is made from saw-dust, which, under the influence of a high temperature and the enormous pressure of 600 tons, acquires a hardness a good deal exceeding that of wood. It is of a very fine grain, and fears no atmospherical variation; but its principal merit is its adaptation to moulding, and by the most economical processes forms and impressions are given which would require, in any other way, considerable labor and workmanship. We have seen various articles of great beauty manufactured from it, such as writing-desks, inkstands, seal-handles, medallions of royal and public charac-

ters, and even binding for books; on these, carving and the most delicate sculpture are reproduced with the perfection of models, and with exquisite fineness of execution. In Manchester there are one or two places where the products of this new art can be seen.

Translated for the Journal of the Franklin Institute.

Diathermancy of Gases. By M. Magnus.

M. Magnus read to the Academy at Berlin the second part of his researches on the Diathermancy of Gases. After having in his first memoir established the conductivity of gases in general and especially that of hydrogen, he now examines their power of diathermancy.

The following are, in few words, the results to which he has come:

All gases stop a portion of the calorific rays which traverse them; and absorb more in proportion as they are more dense.

The atmospheric air and the gases which compose it, are those which suffer the most heat to pass through them.

Rays coming from different sources undergo different modifications; those from boiling water present the greatest differences in traversing different gases.

Among the colorless gases, ammonia allows the least heat to pass; after ammonia, olefiant gas.

The use of a tube increases the effects of calorific radiation, as it does those of luminous rays. The nature of the wall of the tube exerts a sensible influence upon the proportion of rays transmitted and absorbed; it follows that reflexion from the surface, modifies the composition of the beam which is traversing the gas.

This latter result might have been anticipated, after the experiments of M. Knoblauch.—*Cosmos.*

On the Preservation of Stone.

From the Civ. Eng. and Arch. Jour., March, 1861.

A series of special meetings has been held at the Royal Institute of British Architects, at the instance of Mr. Tite, M. P., for the discussion of the various processes for the preservation of stone from decay. Mr. Tite opened the discussion, and Mr. Digby Wyatt, the Vice-President, on the three evenings devoted to this subject, occupied the chair.

Mr. Tite gave a very detailed account of the various processes, and expressed his own opinion of the non-success of the applications in each case. Both in opening and closing the discussion, he denounced the processes of M. Szerelmey and Mr. Daines.

Mr. Burnell, after speaking warmly in disfavor of M. Szerelmey's Zopissa—which he said he had gathered in exfoliated scales that had fallen from the walls operated upon, and, in older specimens, had brushed off in clouds with his hand—stated that he knew of no process to which he could pin his faith or reputation.

The Hon. W. Cowper, M. P., said that, having the custody of the

Houses of Parliament, as First Commissioner of Works, he was most anxious to avail himself of the united experience of this Institute. That when he came into office, Sir C. Barry had recommended the process of M. Szerelmey, but that, on extended trial, it was found not advisable to proceed with its further adoption.

Mr. George Gilbert Scott stated that he had tried all the various processes upon the Abbey at Westminster, but all had proved failures in a greater or less degree. He good-humoredly chided M. Szerelmey for falsifying the character of his process, and finally stated that no system had yet gained his confidence.

Mr. Warrington—who stated, in reply to the chairman, that he was engaged professionally for Mr. Ransome—said a few words in support of the process on which he had been employed.

Mr. C. H. Smith, one of the commission appointed to select the stone for the Houses of Parliament, entered rather fully into the circumstances under which he became attached to that commission, and the steps that were taken for the selection of the stone; further remarking upon the negligence of the authorities in not appointing an overlooker properly to inspect the stone as it left the quarries. Certain changes had taken place in the spots from which the stone was obtained, which at last varied to the distance of six miles from the locality originally fixed upon. He had himself been offered the post of supervisor, but had not been able to discover a responsible paymaster. Had this been done, the stones so notoriously bad would not have been used in the building.

Prof. Ansted, in support of his colleague Mr. Ransome, said all that could be said in extenuation of the failures of his process, for the most part attributing them to unfavorable circumstances during the manipulation; but also venturing to suggest that some stones could not be preserved from decay, when decay once set in, by any process whatever. He acknowledged the state of things to be very unsatisfactory, and suggested that the matter be referred to a committee of scientific men for a more thorough investigation.

Mr. Godwin gave some facts in the shape of negative evidence. He had witnessed the failure of Mr. Daines' process of sulphur and oil on a statue in front of the Foundling Hospital, which, after many attempts to preserve it, had fallen into such a state of decay that it had to be placed in the hands of the painters. He had the testimony of Mr. Calder Marshall to the complete failure of the process. He inveighed against the disfiguring of the Houses of Parliament by the inventors of so-called preserving processes, some few of whom had raised an agitation to suit their own purposes, and had gone far towards irremediably spoiling the characteristics of that superb building.

Mr. Ferrey spoke in favor of soft soap and alum, as being so cheap that its price would compensate for its frequently required application.

Mr. E. Barry exonerated his late father from imputed blame in the employment of Szerelmey's Zopissa on the New Palace; stating that qualified authorities had preferred this process to Mr. Ransome's, whose process he considered a failure, but the specimens of which he

had now labeled on the building, so that any one might have an opportunity of inspecting the result for themselves.

Prof. Hofmann stated his opinion on the process of M. Fuchs; but confessed that, beautiful as was the theory of the system, it was not suited to the humid atmosphere of England. He stated his objection to Mr. Ransome's process, which even as a theory he had pronounced a failure, as silicate of lime formed by precipitation of silica by calcium had no chemical affinity whatever with the constituents of the stone, and formed no union with it. He concluded by suggesting that the silicic ether, of which he had given a clear description, might be experimented upon to advantage.

Dr. Frankland, who in accordance with a previous request of Mr. Godwin stated that he was professionally employed by Mr. Ransome, spoke of the silicate of lime process; and ended by saying that, as the price of silicic ether was six guineas per lb., it could hardly be used for the purpose required.

Prof. Tennant coincided with the opinions of Prof. Hofmann on the subject principally under consideration.

After some further remarks from other speakers, the motion proposed by Mr. Godwin and seconded by Mr. Tite was carried unanimously—that the First Commissioner be requested to stay further proceedings at the New Palace at Westminster, and to form a committee of inquiry into the present state of decay of the building, and the best mode of arresting its further progress.—*Proc. Inst. of Brit. Arch.*

Gun-Cotton as a Filter. By Prof. Böttger.

Gun-cotton, being produced by the action of very powerful acids, and being, according to the experiments of the author, scarcely attacked by even the most energetic re-agents at ordinary temperatures, provided it have been well prepared, may be very advantageously used for filtering very acid liquids, and those easily affected, and in many cases is preferable to the substances heretofore used.

M. Böttger has used this means of separating chloride of silver from strong nitric acid; selenium from fuming sulphuric acid; crystals of chromic acid from sulphuric acid; and for the filtration of strong alkalies.—*Böttger's Polytechnisches Notizblatt* and *Dingler's Polytechnisches Journal;* quoted by *Bulletin de la Soc. d'Encouragement pour l'Industrie Nationale.*

Paper from Maize.

The French have discovered that paper can be made from Indian corn; and what is more curious, the *Cosmos* admits that the discovery is not entirely new. This is probably owing to its not being claimed by a Frenchman; otherwise, it is at least as new as blasting by galvanism, copying by telegraph, &c., &c., of which so much boasting is made.

But to the facts: M. Moritz Diamant, an Austrian, has invented a

process of making paper from Indian corn, which is now in use by M. le Comte Lippe-Weissanfeld.

All kinds of paper may be made from it, and in some respects the papers are superior to those made from rags. It requires but little sizing to fit it to receive ink, the natural leaf containing a substance which answers for it, but which can easily be extracted when desirable. It is bleached rapidly, easily, and inexpensively, and may be used for wrapping-papers without bleaching, as it is but slightly colored. It is stronger than the best paper from rags and has not the brittleness of straw-paper.

In M. Moritz's process, as no machine is necessary to convert the fibre into pulp, and this conversion is done in an entirely different way from the manufacture of paper from rags, there results a great simplification in the tools and a consequent notable reduction in the cost of making. A manufactory is now in operation in Switzerland. It is worthy of remark that the richest leaves in textile material are those which envelope the ear.—*Cosmos.*

On the Difference in Size of Medals of Different Metals obtained by Stamping, and by Casting in the Same Mould. By H. W. Dove.

From the Lond. Edin. and Dub. Phil. Mag., October, 1860.

Baudrimont has found (*Ann. de Chim. et de Phys.* vol. lx. p. 78) that wires of different metals drawn through the same press are not all of the same thickness; for they are of different degrees of elasticity, and after being drawn through the press they expand to different amounts. This expansion is proved by the fact that, with the exception of gold wire, no wire can be drawn through the same aperture through which it has been pressed. Silver requires the least force, but the expansion caused by elasticity continues for several weeks.

It appeared probable that in stamping medals something similar would prevail, and that medals of different metals stamped in the same die would be different in size. This is most readily seen in those medals in which the impression is symmetrically arranged in reference to the edge, as is the case with the medals of the French Exhibition, in which the coats of arms encircle the French eagle in the middle. One of those in silver, and one in bronze, were placed in the stereoscope, the eagle being fixed in the middle. After some time, the stereoscopic combined medal was seen in the form of a hollow escutcheon, and of the color of an alloy of the two metals. Evidently, the reason of this lies in the nonius-like shifting of the individual lines of the impression. This result, which I have described (*Optische Studien*, p. 29), I have also obtained with large gold and silver medals which were kindly entrusted to me from the Royal Mint in Berlin. It was probable that medals obtained by casting would show the same thing, and this was found to be the case with tin, bismuth, and lead. The casts were very beautifully executed for me for this purpose by Prof. Kiss. Hiero's crown led to the application of specific gravity to detect an adulteration; the stereoscope is a new means.—Poggendorff's *Annalen*, vol. cx. p. 498.

Painting by Centrifugal Force.

In the establishment of M. Deffner, at Esslingen, among other objects, they make large quantities of bird-cages. In order to paint the wires, they are first immersed in a vessel of the paint, suffered to drip for a few minutes, and then placed in boxes on the circumference of a horizontal wheel of about two feet diameter which is turned with great rapidity. By the centrifugal force thus generated, the excess of paint is thrown off, and a thin and even coating only is left.—*Mittheilungen des Hanoverschen Gewerbevereins; Bull. de la Soc. d'Encour. pour l'Ind. Nat.*

Sulphide of Phosphorus for Matches.

M. Puscher, of Nuremburg, proposes the use of sulphide of phosphorus in place of the phosphorus itself, in the manufacture of matches. It is easily made by taking 4 parts by weight of phosphorus and 1 of sulphur coarsely powdered, placing them in a vessel of porcelain and covering them with water at 100° Fah.; in a few minutes the liquid sulphide is formed. The water is poured off as far as possible and a cold, and very thick solution of gum is added. The sulphuret mixes with this solution with great ease and rapidity. The sulphide of phosphorus is fluid even at 32°, and inflames more easily by friction in the air than phosphorus itself. Excellent matches may be made by using only 3½ per cent. of the sulphide. When the sulphide and gum are thoroughly powdered, the other ingredients, such as peroxide of lead, nitrate of lead, and a little sulphide of antimony are added. As the mixture is made cold, some rosin may be added to augment the flame. There is thus a great economy, both of phosphorus and of time, and the matches thus prepared have less smell than those made with phosphorus alone.—*Dingler's Polytechnisches Journal; Bull. de la Soc. d'Encour. pour l'Ind. Nat.*

AMERICAN PATENTS.

AMERICAN PATENTS ISSUED FROM APRIL 1, TO APRIL 31, 1861.

Adhesive Material,	A. J. Russell,	City of	N. Y.	2
Air Engines,—Hot	Stephen Wilcox, Jr.,	Westerly,	R. I.	2
———,—Steam and Hot	Darius Musselman,	Lucas co.,	Ohio,	30
Amalgamator,	S. E. Woodworth,	Murphy's,	Cal.	9
Augers,—Hollow	S. P. Gilbert,	Racine,	Wis.	2
Axes,—Manufacture of	Levi Dodge,	Cohoes,	N. Y.	2
Axgave Americana,—Dressing	E. J. y Patrullo,	Merida,	Mexico,	23
Baby Jumper,	J. A. DeBrame,	City of	N. Y.	30
Barometer,	H. A. Clum,	Auburn,	"	16
Bathing Apparatus,	J. C. Schooley,	Cincinnati,	Ohio,	2
Bed,—Portable Folding	G. N. Seidler,	Hartford,	Conn.	2
——,—Spring	Stewart Elder,	Buffalo,	N. Y.	23

Bed Bottom,—Spring	J. J. McCormick,	Paterson,	N. J.	30
———	Joseph Stevens,	Lowell,	Mass.	23
Bedstead,—Portable Folding	H. W. Eastman,	Baltimore,	Md.	9
Bedsteads,—Fracture	Ezekiel Daniels,	Owego,	N. Y.	9
Bee-hives,	Alexander Clow,	Waterford,	Penna.	16
———	Samuel Ide,	East Shelby,	N. Y.	2
———	Orlando Miller,	Girard,	Penna.	2
———	Hugh H. Whitney,	Waterford,	"	30
Blasting Powder,—Composit. for	Thomas & Emanuel,	Catasauqua,	"	9
Boats,—Attaching and Detach.	Hunter Davidson,	U. S. Navy,		9
Boat Detaching Apparatus,	Wm. M. Van Wagener,	Newark,	N. J.	16
Boilers for Hot Water Apparat.	Edward Horalek,	City of	N. Y.	9
Bolting Chests,	Joseph Bell,	Belleville,	Ill.	9
Bookcase,	Anthony Lamb,	Cambridge,	Mass.	16
Boot Crimp,	J. G. Whittier,	Attica,	Ind.	2
—— and Pantaloon Jack,	Clough & Day,	Brooklyn,	N. Y.	30
Boots and Shoes,	A. O. Crane,	Hoboken,	N. J.	23
———	L. and S. B. Holden,	Woburn,	Mass.	2
Boring Machine,	E. P. Drake,	Greenbush,	N. Y.	23
Bracelets,	Henry Kipling,	City of	"	2
Brake,—Wagon	Josiah Long,	Morristown,	Ind.	2
Brakes for Carriages,	J. E. Briggs,	Watertown,	N. Y.	2
Brick Machines (2 patents),	John Caswell,	Syracuse,	"	16
———	W. S. Watson,	Madison,	Ind.	2
Bridges,—Truss Frames of	J. W. Murphy,	Philadelphia,	Penna.	30
Brush,—Scrubbing	Wm. L. Haller,	"	"	30
Buckles,	John E. Smith,	Waterbury,	Conn.	23
Bullets,—Machine for Making	Richard Gornall,	Baltimore,	Md.	30
Buoying Vessels,—Apparat. for	E. Goulard,	City of	N. Y.	2
Button Fastenings,	W. Kuhlenschmidt,	"	"	23
——— Fasteners,	Joseph Lofvendahl,	East Boston,	Mass.	16
Cannon Balls,—Protect. Vessels	Francis Comtesse,	City of	N. Y.	23
Carpet Fastener,	M. D. and S. A. Snyder,	Clarendon,	"	16
——— Linings,	J. R. Harrington,	City of	"	23
Carriage Hubs,—Boxes of	J. A. Cramer,	Brooklyn,	"	2
Cartridge Loaders,	Edward Maynard,	Washington,	D. C.	2
Carriage Tops,—Braces for	B. F. Hooper,	Birmingham,	Conn.	9
Carriages,—Children's	Crandall & Conover,	City of	N. Y.	2
Car Ventilator,	J. B. Bausman,	Rochester,	Penna.	9
Cheese Presses,	Calvin Auborn,	Watertown,	N. Y.	9
———	John Patterson,	Indianapolis,	Ind.	23
——— Vat,	D. W. Maples,	Homer,	N. Y.	30
——— Operator,	C. M. Wilkins,	W. Andover,	Ohio,	2
Cider Mills,	Saml. & R. W. Caldwell,	Chillicothe,	"	16
Clock Escapement,	John C. Pitel,	Meriden,	Conn.	23
Cloth,—Tentering and Drying	J. S. Winson,	Providence,	R. I.	9
Clothes Dryer,	Ezra Buss,	Yellow Springs,	Ohio,	2
———	Duane Hull,	Newburgh,	N. Y.	9
———	Chas. Robinson,	Cambridgeport,	Mass.	23
——— Frame,	L. L. Knight,	Barre,	"	16
——— Wringer,	Ezariah Spaulding,	Morrisville,	Vt.	16
——— to a Tub,—At.	David Lyman,	Middlefield,	Conn.	2
Coal and Ores,—Desulphurizing	J. I. Storer,	Philadelphia,	Penna.	9
—— Sifter,	David J. Starrett,	Thomaston,	Me.	30
—— Scuttle,	J. G. Treadwell,	Albany,	N. Y.	23
Coffee Pots,	H. W. Mosher,	Warren,	Ill.	23
———	David Stewart,	Annapolis,	Md.	9
——— Steeper,	R. S. Sanborn,	Sycamore,	Ill.	2
Copying Presses,—Portable	J. H. Atwater,	Providence,	R. I.	2
Core Carriages,	Samuel Fulton,	Conshohocken,	Penna.	16
Cork-cutting Machines,	Alexander Millar,	City of	N. Y.	9
—— Machines,	"	"	"	16

Corn Planters,—Hand	S. P. Briggs,	Saratoga Spr's,	N. Y.	30
———	W. C. Ford,	West Salem,	Ohio,	9
———	J. M. Foy,	FountainGreen,	Ill.	16
———	David Humphreys,	Cincinnati,	Ohio,	16
———	C. K. Myers,	Pekin,	Ill.	23
———	Powers Ritchey,	Hamilton,	"	16
———	Stone & Archibald,	Wapello,	Iowa,	16
—— Stalks,—Cutting Standing	T. J. Freeman,	Heyworth,	Ill.	2
Cotton Cultivators,	G. W. Rice,	Demopolis,	Ala.	16
—— Presses,	Tilmon Gilbert,	Natchez,	Miss.	9
Couplings,—Car	F. B. Hall,	Hartford,	Conn.	30
Cranks,—Avoid. Dead Centres	Turner Williams,	Providence,	R. I.	2
Cultivators,	C. W. Emerson,	Albany,	N. Y.	23
———	O. W. Goslee,	Glastenbury,	Conn.	2
———	J. A. Spear, Jr.,	Manchester,	Penna.	9
———	Isaac Stout,	Tremont,	Ill.	16
———	Wm. F. Veber,	Bowling Green,	Ohio,	2
Cultivator Teeth,	Wm. Morrison,	Chadd's Ford,	Penna.	16
Curtain Fixture,	George Gatty,	City of	N. Y.	16
—— Roller,—Shade or	Langdon Sawyer,	Springfield,	Vt.	9
Cylinders,—Casting Copper	Freeborn Adams,	Somerville,	Mass.	30
Deep Sea Sounding,—Cup for	W. P. Trowbridge,	Washington,	D. C.	16
Derricks,—Floating	G. W. Brush,	Brooklyn,	N. Y.	9
Disinfecting Foul Air in Vessels,	Alois Peteler,	New Brighton,	"	9
Door Alarms,	Curtis & Tufts,	Charlestown,	Mass.	9
—— Bolt,	Benj. Russell,	Brooklyn,	N. Y.	9
—— Lock,	Solomon Fry,	Monongahela,	Penna.	30
—— Spring,	J. O. Blythe,	Germantown,	"	2
Drain Tiles,	Adam Newkumet,	Philadelphia,	"	16
Excavator,	Archibald Kirby,	Paris,	Ill.	30
Excavators,	Wm. Randall,	Uxbridge,	Canada,	2
Extracts under Pressure,—mak.	A. A. Burlingame,	City of	N. Y.	9
Eyelet Machines,	S. J. Smith,	"	"	16
Faucets,	J. S. Davison,	Cranberry,	N. J.	16
———	John Neumann,	City of	N. Y.	30
Feathers,—Dressing	Samuel Orr,	E. Springfield,	Ohio,	9
Felting Machines,	G. N. Bronson,	New Milford,	Conn.	16
Filters,	George Norris,	City of	N. Y.	30
Fire Arms,	W. McCord,	Sing Sing,	"	2
———,—Breech-load. (2 pat.)	J. H. Merrill,	Baltimore,	Md.	9
———,—Locks of	Prince Hiller,	Mattapoisett,	Mass.	30
—— Grates,	Joseph Tiberi,	St. Louis,	Mo.	2
Floor Clamp,	J. L. Clough,	Suffield,	Conn.	23
Fly Wheels,—Arranging	H. B. Peck,	Wolcott,	N. Y.	2
Fog Bells,—Operating	John Haynes,	Pembroke,	Me.	2
Fracture Apparatuses,	Theodore Burr,	Battle Creek,	Mich.	30
Fringe,—Making	L. D. Valetton,	City of	N. Y.	2
Garden Hoe,	Jonathan Howard,	W Bridgewater,	Mass.	9
Gas,—Appar. for Naphthalizing	W. H. Gwynne,	City of	N. Y.	30
—— Burners,	Leffingwell & Thompson,	Newark,	N. J.	2
——,——— for Purifying	John Danks,	Troy,	N. Y.	23
—— from Wood,—Retorts for	Mark Levy,	City of	"	9
—— Meters,	Samuel Glegg,	Putney,	Engl'd,	16
—— Retorts,	S. H. and M. C. Walker,	Boston,	Mass.	9
———,—Construction of	John M. Gallacher,	Roxbury,	"	30
Gates,	G. C. Flagg,	Tanktown,	Ohio,	9
Geometrical Lines, &c.,—Deter.	R. B. Light,	Dunkirk,	N. Y.	9
Gins,—Cotton	J. F. Brown,	Columbus,	Ga.	23
Grain Cradles,	Daniel H. Viall,	Schaghticoke,	N. Y.	30

Grain Separators, .	George Lull, .	Hardin,	Iowa,	16
——————— .	Andrew Hunter, .	Solano co.,	Cal.	9
——————— .	Linus Merrill, .	Janesville,	Wis.	9
——————— .	Turner & Vaughn, .	Cuyahoga Falls,	Ohio,	9
——————— .	Wirtz & Swift, .	Hudson,	N. Y.	16
Halter Ring, .	L. C. Chase, .	Boston,	Mass.	30
Hammers, &c.,—Handle for	Thomas Phillips,	Ann Arbor,	Mich.	9
Harness,—Safety Hook for	Henry Beagle, Jr., .	Philadelphia,	Penna.	9
Harrow Frames, .	J. Brainerd and others,	Cleveland,	Ohio,	2
Harvesters, .	Adam Pritz, .	Dayton,	"	16
————,—Raking Attach.	G. E. Chenowith,	Baltimore,	Md.	9
————,—Rakes for .	Chester Bullock, .	Jamestown,	N. Y.	23
Harvesting Machines,	T. C. Hargrave,	Schenectady,	"	30
——————— .	F. H. Manny, .	Rockport,	Ill.	30
———————	Thomas S. Whitenack,	Easton,	Penna.	30
Hats and Caps,—Shaping, &c.,	A. L. Bayley, .	Amesbury,	Mass.	9
Heating Buildings,—Furnaces	Joseph Leeds, .	Philadelphia,	Penna.	2
Hemp Brakes, .	J. R. McDonald, .	Fayette,	Mo.	2
Hinges,—Making Butt	Brown & Van Gieson,	Waterbury,	Conn.	9
Hoes,—Handle for .	Samuel Reynolds, .	Duquesne Bor.,	Penna.	23
Hooks and Eyes, .	A. C. Mason, .	Springfield,	Vt.	9
Horse-shoe Machine, .	D. N. Allard, .	McConnelsville,	Ohio,	9
Horse-shoes,—Toe Calkin for	C. H. Perkins, .	Providence,	R. I.	9
Ice Cream Freezers, .	H. B. Masser, .	Sunbury,	Penna.	23
Inkstands, .	J. W. Ross, .	Boston,	Mass.	30
Iron Castings,—Reducing, &c.,	C. R. Ely, .	Shelden,	Vt.	2
Key Fastener, .	E. H. Bailey, .	Philadelphia,	Penna.	9
——,—Edge .	Edwin Campbell, .	Bath,	Me.	30
Knitting Machines,	J. K. and E. E. Kilbourn,	Norfolk,	Conn.	9
Ladder, .	George Aldrich, .	Armada,	Mich.	30
——— Hook,—Adjustable	W. T. Farrar, .	Concord,	Mass.	9
Lamps, .	J. E. Ambrose, .	Lena,	Ill.	23
——— .	M. L. Callender,	City of	N. Y.	23
——— .	J. T. Clegg, .	Philadelphia,	Penna.	2
——— .	Frederick Heidrich,	"	"	2
——— .	Anson Judson, .	Brooklyn,	N. Y.	9
——— .	Stuber & Frank,	Utica,	"	23
——— .	Joseph Thomas, .	City of	"	23
Lanterns, .	E. B. Coffin, .	Johnston,	R. I.	23
——— .	G. H. Magersuppe, .	City of	N. Y.	2
Lath Machines, .	Albert Gummer,	Indianapolis,	Ind.	16
Leather,—Finishing .	Wm. Ellard, .	Woburn,	Mass.	2
Linen Smoother, .	Horatio Rodd, .	Chestnut Hill,	Penna.	9
Locks (2 patents), .	Henry Hartwig, .	City of	N. Y.	30
Lock,—Combination	Fred. W. Alexander,	Baltimore,	Md.	30
Looms, .	George Crompton, .	Worcester,	Mass.	23
——— .	George Copeland,	North Gray,	Me.	9
——— .	John Shinn, .	Leverington,	Penna.	30
———,—Hair Cloth	John Nobbit, .	Philadelphia,	"	9
———,—Let-off for .	W. H. Gray, .	Dover,	N. H.	9
———,—Pickers for	Samuel Boorn, .	Lowell,	Mass.	9
———,—Power .	Thomas King, .	West Farms,	N. Y.	16
Match Boxes, .	S. W. Francis, .	City of	N. Y.	30
Meat,—Preserving .	D. E. Somes, .	Biddeford,	Me.	9
Mill Picks, .	Peter Faver, .	City of	N. Y.	9
——————— .	Benjamin Hostler, .	Brookfield,	N. Y.	30
Mining Pan, .	John A. Brock, .	Chicago,	Ill.	23
Mosquito Net, .	Voorhis & Whiteman,	City of	N. Y.	9
Motion,—Transmitting	J. W. Howlett, .	Greensboro',	N. C.	9

Mowing Machines,	E. F. and J. Herrington,	W. Hoosick,	N. Y.	9
———	J. H. Rible,	Dayton,	Ohio,	2
Muzzles for Dogs, &c.,	C. F. Schmidt,	Williamsburgh,	N. Y.	2
Newspaper Files,	H. S. White,	Newport,	R. I.	2
Oil Cans,—Cap for	J. H. Breckinridge,	Meriden,	Conn.	2
Oils,—Distilling	Abraham Quinn,	City of	N. Y.	9
——,—Distilla. of Hydro-carbon	J. J. Johnston,	Alleghany,	Penna.	9
Ordnance,—Breech-loading	J. S. Butterfield,	Philadelphia,	"	30
Pantaloons,—Guides for Cutting	Ramsey & Smith,	Clinton,	Penna.	23
Paper,—Letter	T. H. Dodge,	Washington,	D. C.	23
——Stock,—Preparing	A. Randel,	City of	N. Y.	30
Photographic Medals,	H. E. Copely,	Waterbury,	Conn.	2
Photographs on Paper,—Varnish.	D. W. S. Rawson,	Galena,	Ill.	2
Piano-fortes,—Square	C. F. Chickering,	City of	N. Y.	23
Picture Frames,—Enameling	Sperry & Sherwood,	"	"	2
Pipe,—Moulds for Casting	Samuel Fulton,	Conshohocken,	Penna.	16
—— Joint,	A. C. Jones,	Philadelphia,	"	23
Pistols,—Gun Stocks to	E. B. Savage,	Cromwell,	Conn.	9
Plough. & Till. Land (3 pats.),	John Fowler,	Leeds,	Engl'd,	9
Ploughs,	G. W. Cooper,	Palmyra,	N. Y.	16
———	J. B. Cooper,	Brooklyn,	"	9
———	Valentine Felker,	Carmel,	Me.	30
———	E. J. Fraser,	Kansas,	Mo.	23
———	H. F. Mann,	Laporte,	Ind.	16
———	Partlett & Thompson,	Elmira,	N. Y.	2
———	Franklin Traxler,	Salem,	Mich.	16
———,—Steam	John K. Smith,	Trenton,	N. J.	23
———,—Subsoil	James McCollum,	Brownsville,	Ala.	23
Potatoes,—Machines for Digging	Conover & Spring,	City of	N. Y.	30
Power,—Transmitting	T. J. Lowry,	Conneautsville,	Penna.	16
Presses,	Huddleston & Harrison,	Lawrence,	Kansas,	9
——,—Printing	F. L. Bailey,	Boston,	Mass.	30
———	G. P. Gordon,	Brooklyn,	N. Y.	23
Pumps,	Harvey Locke,	South Boston,	Mass.	30
———	G. W. Martin,	Morrisania,	N. Y.	9
———	A. M. Perkins,	Springfield,	Mass.	2
———,—Operating	James Armstrong,	Dobbinsville,	N. C.	16
——,—Rotary	C. L. Johnston,	Little Falls,	N. Y.	9
Railroad Cars,—Stop. and Start.	J. A. Emerick,	Philadelphia,	Penna.	23
——— Chair and Splice,	E. F. Barnes,	Brooklyn,	N. Y.	23
——— Indicator,	M. T. Ridout,	Milwaukie,	Wis.	9
——— Rails,—Joints for	Reymond French,	Seymour,	Conn.	16
———,—Splicing Rails for	B. A. Mason,	Newport,	R. I.	16
Rakes,—Hay	Wm. Deckman,	Canton,	Ohio,	16
——,—Horse	Jonah Crites,	Orrville,	"	2
Reading Desk,—Night	John Rogowiski,	City of	N. Y.	23
Reapers and Mowers,	D. Hitchings,	Richfield,	"	30
Reels,	Caroline H. Carnes,	City of	"	9
Refrigerator,	C. G. Page,	Washington,	D. C.	2
Rigging Clasp,	George W. Soule,	Freeport,	Me.	30
———,—Setting up Ships	Barton Ricketson,	New Bedford,	Mass.	2
Rocking Horse,	A. Christian,	City of	N. Y.	2
Roofing Cloth,—Making	D. S. Anderson,	Trenton,	N. J.	23
Rotary Engines,	J. B. Root,	Battle Creek,	Mich.	30
——— Motion,—Registering	F. B. Hall,	Hartford,	Conn.	23
Salt Kettles,—Construction of	O. W. Seely,	Albany,	N. Y.	9
Sash Fastener,	J. C. Butterworth,	Providence,	R. I.	16
Saw Plates,—Hardening	James Dodge,	Waterford,	N. Y.	16
Saw-set,	Amos Call,	Springfield,	Mass.	30

Sawing Machines,—Cross-cut	S. S. Dice,	Stark co.,	Ohio,	2
Screws and Tacks,—Head for	G. R. Wilmot,	West Meriden,	Conn.	9
Seed Planters,	Daniel Broy,	Canton,	Mo.	23
———	T. W. White,	Milledgeville,	Ga.	16
———	L. R. Wright,	Cohoes,	N. Y.	16
—— Drills,	G. W. Nevill,	Bath,	Ill.	16
Seeding Machines,	Bacon & Fowler,	Ripon,	Wis.	16
———	C. W. Cahoon,	Portland,	Me.	9
———	George Harlan,	Brownsville,	Ind.	30
———	T. S. Mills,	Iberia,	Ohio,	23
Sewers,—Inlet for	W. H. Short,	Brooklyn,	N. Y.	9
Sewing,—Finger Shield for Hand	A. H. Downer,	City of	"	2
———,—Hemmers for Hand	J. O Whitcomb,	"	"	9
——— Machines,	A. H. Boyd,	Rockville,	Mass.	2
———	Theodore Burr,	Battle Creek,	Mich.	9
———	W. C. Hicks,	Boston,	Mass.	16
———	G. H. Mallory,	City of	N. Y.	2
———	H. L. Shaw,	Milan,	Ohio,	9
———	J. D. Alvord,	Bridgeport,	Conn.	16
Shearing Sheep-skins,	Wm. D. Cutler,	Millbury,	Mass.	30
Shot Pouches,	C. Johnston,	Clarksville,	Mo.	16
Shuttle Fastener,	Wm. M. Griscom,	Philadelphia,	Penna.	30
Signs,	W. B. Little,	City of	N. Y.	30
Skates,	Bassford & Carpenter,	"	"	30
———	J. A. De Brame,	"	"	9
———	G. S. Curtis,	Chicago,	Ill.	23
———,—Roller	Henry Pennie,	Brooklyn,	N. Y.	9
Skirts,	T. B. DeForest,	Birmingham,	Conn.	2
——,—Manufacturing Skeleton	R. J. Mann,	Brooklyn,	N. Y.	2
Smoking Tubes,	Boeklen & Staehlen,	"	"	2
Soaps,	W. E. Dawson,	Lynchburg,	Va.	9
Spading Machines,—Rotary	Donald Mann,	Rochester,	N. Y.	23
Spike Machines,	James H. Swett,	Pittsburgh,	Penna.	30
Spinal Curvat's,—Reduc. (3 pat.)	C. F. Taylor,	City of	N. Y.	9
Spinning Frames,	F. S. Stoddard,	Litchfield,	Conn.	23
——— Machines,—Bobbins for	J. A. Bazin,	Canton,	Mass.	9
——— Machinery,	George Goulding,	Watertown,	N. Y.	16
———	Chas. Hardy,	Biddeford,	Me.	9
Springs,—Carriage	P. G. Gardiner,	City of	N. Y.	2
Stable Broom,	Richmond & Wright,	"	"	16
Stave Machines,	James Nevison,	Morgan,	Ohio,	2
Steam and Air,—Combining &c	Rogers & Black,	Philadelphia,	Penna.	23
——— Boilers,	Francis B. Blanchard,	Brooklyn,	N. Y.	2
———	G. W. Rains,	Newburg,	"	30
———,—Combustion in	Tiffany & Heermance,	City of	"	2
———,—Feed water ap.	L. X. Gargan,	Paris,	France,	16
———	W. A. Lightfall,	City of	N. Y.	9
———,—Furnaces for	James Millholland,	Reading,	Penna.	16
———,—Gas Generat.	John Laing,	Hoboken,	N. J.	9
———,—Safety Plugs	J. R. Robinson,	Boston,	Mass.	30
——— with water,—sup.	Rensalier Jadwin,	Grafton,	Ohio,	16
———,—low wat. alarm	Adam Carr,	Paterson,	N. J.	16
———,——— indic.	S. W. Warren,	Brooklyn,	N. Y.	30
——— Cock,	Alfred Swadkins,	South Boston,	Mass.	30
——— Engines,	J. R. Armstrong,	Kendallville,	Ind.	16
———	J. R Robinson,	Boston,	Mass.	30
———	S. H. Whitmore,	Cincinnati,	Ohio,	2
———,—Feed water	Benjamin Crawford,	Pittsburgh,	Penna.	2
———,—Pistons of	L. B. Batcheller,	Rochester,	N. Y.	30
———	J. O. Haight,	Albany,	"	9
——— Pump,	Martin Wilcox,	Middlebury,	Ohio,	2
——— Trap,	John Gunn,	Worcester,	Mass.	23
Stoves,	Bibb & Augee,	Baltimore,	Md.	30

Stoves,	John Magee,	Lawrence,	Mass.	23
——,—Cooking	A. C. Barstow,	Providence,	R. I.	30
——	H. H. Huntley,	Cincinnati,	Ohio,	2
——	Wm. Resor,	"	"	16
Straw Cutters,	O. B. Wattles,	Mooresboro,	N. C.	16
Street Cleaning Machines,	Wm. H. Hope,	Washington,	D. C.	30
——	Loughlin Conroy,	City of	N. Y.	16
Stump Extractor,	Frederick Ketler,	Milwaukie,	Wis.	30
Suspender Buttons,	Edwin Smith,	Naugatuck,	Conn.	16
Tablets,	Wenisch & Berky,	Tompkinsville,	N. Y.	16
Telegraph,—Electro-magnetic	A. E. Parks,	Brooklyn,	"	2
Telegraphic Cable,	T. W. Evans,	Philadelphia,	Penna.	30
Temples,	Hoffman & Graichen,	Clinton,	Mass.	9
Tenoning Machine,	Bain & Brown,	Richmond,	Ind.	16
Thimbles,	B. W. Hood,	Pawtucket,	Mass.	9
Thread-winding Guides,	T. B. DeForest,	Birmingham,	Conn.	9
Threshing Cylinder, &c.,	Chas. Bailey,	Batavia,	Ill.	23
—— and Cleaning Clover,	Wm. Rowe,	Charlestown,	Va.	30
—— Separating Grain,	Cyrus Roberts,	Belleville,	Ill.	16
Tires for Locomotive Wheels,	Wm. W. Snow,	Jersey City,	N. J.	23
Training Horses, &c., to Rack,	Commodore Daniels,	Barnwell C. H.,	S. C.	30
Turpentine and Resin,—Manuf.	Henry Napier,	Brooklyn,	N. Y.	9
Valve Arrangement,	Lewis Eikenberry,	Philadelphia,	Penna.	16
Valves for Pumps,	C. A. Clark,	Pulaski,	Iowa,	16
Vegetable Cutter,	J. R. Whittemore,	Chicopee Falls,	Mass.	2
Vessels,—Ascer. Curv. of Keel of	H. E. Toule,	Exeter,	N. H.	23
Vise,	Louis Tilliers,	Mott Haven,	N. Y.	16
Wagon Brakes,	Porter Seward,	Chaseville,	N. Y.	9
—— Locks,	Thomas Service,	Utica,	Penna.	16
Wagons,—Tailboards of	J. O. Farrell,	Boston,	Mass.	23
Washing Machine,	Henry Bailey,	Columbia,	Me.	23
——	Henry Behn,	City of	N. Y.	30
——	Wm. Brannan,	Gloucester,	N. J.	30
——	R. W. George,	Richmond,	Me.	2
——	G. W. and P. W. Gould,	Evans,	N. Y.	30
——	Hutchings & Leach,	Penobscot,	Me.	2
——	E. T. Shepard,	Gallipolis,	Ohio,	23
——	James M. Tolley,	Big Lick,	Va.	30
Watch Escapement,	G. P. Reed,	Roxbury,	Mass.	9
—— and Locket Rims,—Mak.	D. B. Weite,	Providence,	R. I.	23
Water Cooler,—Refrigerator and	Anderson Godley,	Ithaca,	N. Y.	9
—— Elevators,	Ransom Bartle,	Independence,	Iowa,	9
——	Hudson & Billings,	Cleveland,	Ohio,	30
——	Hunt & Kennedy,	Galesburgh,	Ill.	2
——	Calvin Shepherd,	Chenango,	N. Y.	23
—— Pipes,	Arcalous Wyckoff,	Elmira,	"	16
——,—Apparat. for Purifying	Jacobs & Wilkinson,	St. Louis,	Mo.	2
—— Wheels,	Wm. Dripps,	Coatsville,	Penna.	9
——	Chas. Greenawalt,	Seiberlingville,	"	23
——	Haag & Smith,	Bernville,	"	16
——	Kenyon & Brown,	Hopkinton,	R. I.	30
——	I. D. Seely,	Milford,	N. Y.	9
Wheels,—Propelling	Comstock & Glidden,	Milwaukie,	Wis.	30
Wheelwrights Machine,	Curtiss Luther,	Newbury,	Ohio,	16
Wicks,—Trimming	A. R. Turner,	Malden,	Mass.	2
Wrench,	G. W. Martin,	Morrisania,	N. Y.	16

EXTENSIONS.

Bedsteads,—Folding	T. B. Bleecker,	City of	N. Y.	16
Cables,—Work. & Stop. Chain	Thomas Brown,	London,	Engl'd,	16

RE-ISSUES.

Amalgamators,—Gold	Wyckoff & Fell,	Brooklyn,	N. Y.	9
Air Engines,	Philander Shaw,	Boston,	Mass.	23
Bonnet Fronts,	G. A. Cox,	Brooklyn,	N. Y.	23
Cotton Gins,	Campbell & Brown,	Columbus,	Miss.	2
Envelopes,—Making	E. W. Goodale,	Clinton,	Mass.	16
Harvesters, (2 patents)	Huntley Bowman & Co.,	Brockport,	N. Y.	16
————,—Grass	A. W. Morse,	Eaton,	"	2
Hoop Machine,	Amer. Hoop Mach. Co.,	Fitchburg,	Mass.	16
Inkstands,—Fountain	Francis Draper,	E. Cambridge,	"	2
Locks,	L. F. Munger,	Rochester,	N. Y.	2
Pipes,—Hot Air	C. F. J. Colburn,	Newark,	N. J.	2
Seed Drills,	Jonathan Smith,	Tiffin,	Ohio,	2
Steam Boilers,—Combustion in	J. C. Tiffany,	City of	N. Y.	16

DESIGNS.

Stove,—Cooking	N. S. Vedder,	Troy,	N. Y.	2
Stoves (3 cases),	W. W. Stanard,	Buffalo,	"	9
Window Glass,	Chas. Prosbt,	Hudson City,	N. J.	9

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, June 20, 1861.

John Agnew, Vice President, in the chair.
John F. Frazer, Treasurer.
Frederick Fraley, Corresponding Secretary. } Present.
Isaac B. Garrigues, Recording Secretary.

The minutes of the last meeting were read and approved.

Letters from the Institution of Civil Engineers, London, and from the Philadelphia Society for the Promotion of Agriculture, were read.

Donations to the Library were presented by the Royal Society, the Royal Astronomical Society, the Institution of Civil Engineers, the Institute of Actuaries, and the Society of Arts, &c., London; the Oesterreichischen Ingenieurs Veriens, Vienna, Austria; the Smithsonian Institution, Washington, D. C.; Messrs. Field & Ticknor, Boston, Mass.; Capt. Geo. G. Meade, Corps U. S. Topographical Engineers; and Messrs. John W. Nystrom, Prof. John F. Frazer, Prof. John C. Cresson, and Jos. Hutchinson, of Philadelphia.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer read his statement of the receipts and payments for the month of May.

The Board of Managers and Standing Committees reported their minutes.

The Actuary reported that the standing Committee on Meteorology have organized by electing Mr. James S. Whitney chairman for the ensuing year, and appointing the third Thursday afternoon of each month for their stated meetings.

The amendments to the Constitution proposed at the last meeting were discussed, amended, and adopted unanimously.

Mr. Howson exhibited one of Wootten's Patent Hydrostatic Pressure Gauges. This instrument, a further description of which will be given in a future number, is capable of indicating with accuracy hydrostatic pressures ranging as high as 10,000 lbs. per sq. inch.

Mr. Howson also exhibited a specimen of a new Breech-loading Rifle, invented and patented by C. Sharps, Esq., the well-known fire-arm manufacturer of this city.

The barrel is arranged to slide horizontally on the stock, and is operated by a lever which forms the trigger guard, this lever when the barrel is closed against the stationary breech being entirely out of the way, and wholly embedded in the stock with the exception of that portion which forms the guard.

The ammunition used is the well-known metallic cartridge, which has the bullet at one end, an enlargement containing the detonating material at the opposite end, and an intervening charge of powder.

After sliding out the barrel, the cartridge is inserted into the bore, the barrel is moved back by the lever, the action of which not only moves the barrel with its enlargement contained in a recess formed in the breech, but also serves to lock the barrel so firmly that it may be considered a part of the breech.

A hammer with a blunt pointed nipple strikes the edge of the enlargement of the cartridge and explodes the charge.

On moving out the barrel preparatory to reloading the same, the spent cartridge is retained by a small spring catch bearing against the edge of the enlargement of the spent cartridge, which is thus withdrawn from the barrel without any exertion or delay.

A very simple and ingenious device is attached to the stock for locking the lever when the barrel bears against the breech, the unlocking of the lever being accomplished by that movement of the operator's hand which is required to depress the lever and move out the barrel.

A sliding catch is used for guarding the hammer and preventing it from acting on the cartridge when any sudden movement or jerk of the fire arm takes place, thereby preventing unintentional discharges.

A very neat adjustable sight is attached to the barrel, and is so connected with a graduated and numbered quadrant that it can be adjusted and locked in a position to suit any desired range.

From private experiments recently made at Atlantic City, it has been found that the charge from this arm will take effect at a distance of three-quarters of a mile, and that good aim can be taken at any object one-quarter of a mile distant, the load being effective against a body of men half a mile distant.

The accuracy and precision of the arm may be judged from the fact that the inventor at a distance of eighty yards fired twenty balls through a target less than one foot square, in two minutes and three-quarters, each discharge taking effect, and a reasonable time being occupied in taking aim. The arm can, however, if desired, be discharged fifteen times per minute.

BIBLIOGRAPHICAL NOTICE.

Pocket-Book of Mechanics and Engineering, containing a Memorandum of Facts and Connection of Practice and Theory. By John W. Nystrom, C.E. 5th edition, Philadelphia: J. B. Lippincott & Co., 1861.

Mr. Nystrom sends us another excellent little book of mechanical data and memoranda, for which he has made himself celebrated. Our mechanics will find this manual very convenient, well-arranged, and apparently accurate. We have to remark, however, that the French metre given on page 73 as 39·38091 inches, is, by the determination of the Coast Survey, which is an authority in America, 39·3685. This should be corrected. F.

METEOROLOGY.

For the Journal of the Franklin Institute.

The Meteorology of Philadelphia. By JAMES A. KIRKPATRICK, A.M.

MAY.—The mean temperature of the month was 59·38°, nearly five degrees below that for May of last year, and two and a half degrees less than the average for ten years past. The highest thermometric indication was 83° on the afternoon of the 27th, but the 26th was the warmest day of the month, its mean temperature being 73·7°. The coldest day was the 3d, of which the mean temperature was 40°; the lowest (36°) was reached on the morning of the 2d of the month.

The greatest daily oscillation of temperature was 27° on the 5th; the average oscillation for the month 19·55°, nearly 3° greater than the mean for the last ten years. The least daily oscillation was 8° on the 20th, when rain fell nearly all day. The greatest daily range —that is to say, the greatest mean difference between two successive days—was 10½° between the 20th and 21st; the least was 1° between the 23d and 24th. The mean daily range for the month was 5·06°, nearly half a degree less than usual.

The force of vapor and relative humidity were both considerably less than the average, as will more fully appear in the annexed table of comparisons.

During the month, a greater quantity of rain fell than in the corresponding month in any year since 1854, when about one inch more fell. The amount in May, 1854, was 7·299 inches, in May, 1861, 6·240 inches. The number of days on which rain fell (13) was six less than in May, 1860, but was just equal to the average number for ten years. More than half of the rain for the month fell between noon on the 3d and the night of the 6th. In that time 3·420 inches fell.

The sky was entirely clear, or free from clouds, on six days, and completely covered on two days of the month at the hours of observation.

The atmospheric pressure was greatest (30·132 inches) on the morning of the 31st, and least (29·096 inches) on the afternoon of the 27th, making the range for the month 1·036 of an inch. The minimum reading was the lowest observed during the month of May for ten years. The nearest approach to it was in May, 1858, when the lowest was 29·386 inches. Before or after this great depression there was no very notable atmospheric disturbance. The greatest mean daily range for the month was 0·413 of an inch, and occurred between the 27th and 28th; the average for the whole month was 0·156 of an inch.

A Comparison of some of the Meteorological Phenomena of MAY, 1861, *with those of May*, 1860, *and of the same month for ten years, at Philadelphia, Pa.* Latitude 39° 57½′ N.; longitude 75° 10½′ W. from Greenwich.

	May, 1861.	May, 1860.	May, 10 years.
Thermometer.—Highest,	83°	90°	90°
" Lowest,	36	44	35
" Daily oscillation,	19·55	17·20	16·86
" Mean daily range,	5·06	5·20	5·53
" Means at 7 A. M.,	55·40	59·66	58·17
" " 2 P. M.,	65·74	71·03	69·38
" " 9 P. M.,	57·00	61·57	61·15
" " for the month,	59·38	64·09	62·90
Barometer.—Highest,	30·132 in.	30·050 in	30·338 in.
" Lowest,	29·096	29·479	29·096
" Mean daily range,	·156	·100	·124
" Means at 7 A. M.,	29·744	29·828	29·832
" " 2 P. M.,	29 691	29·787	29 797
" " 9 P. M.,	29·726	29·815	29 820
" " for the month,	29·720	29·810	29·816
Force of Vapor.—Means at 7 A. M.,	·282 in.	·395 in.	·353 in.
" " " 2 P. M.,	·284	·421	·373
" " " 9 P. M.,	·297	·420	·374
Relative Humidity.—Means at 7 A. M.,	63 per ct.	76 per ct.	72 per ct.
" " " 2 P. M.,	44	57	52
" " " 9 P. M.,	63	76	69
Rain, amount in inches,	6·240 in.	3·589 in	4·400 in.
No. of days on which rain fell,	13	19	13
Prevailing winds,	S 72°48′ W ·257	S 59°2′ E ·070	S 71°34′ W ·116

SPRING.—The season just closed was the coldest of the last three springs. The mean temperature was about one degree less than that of the Spring of 1860, but was very close to the average for the last ten years. The maximum indication was 88° on the 24th of April, and the minimum was 16° on the 18th of March, making the quarterly range of temperature 72°.

The last ice of the season was formed on the 22d of March, and the last snow fell on the 17th of April. In 1860, the last snow fell on the 25th of April, and the last ice was found on the morning of the